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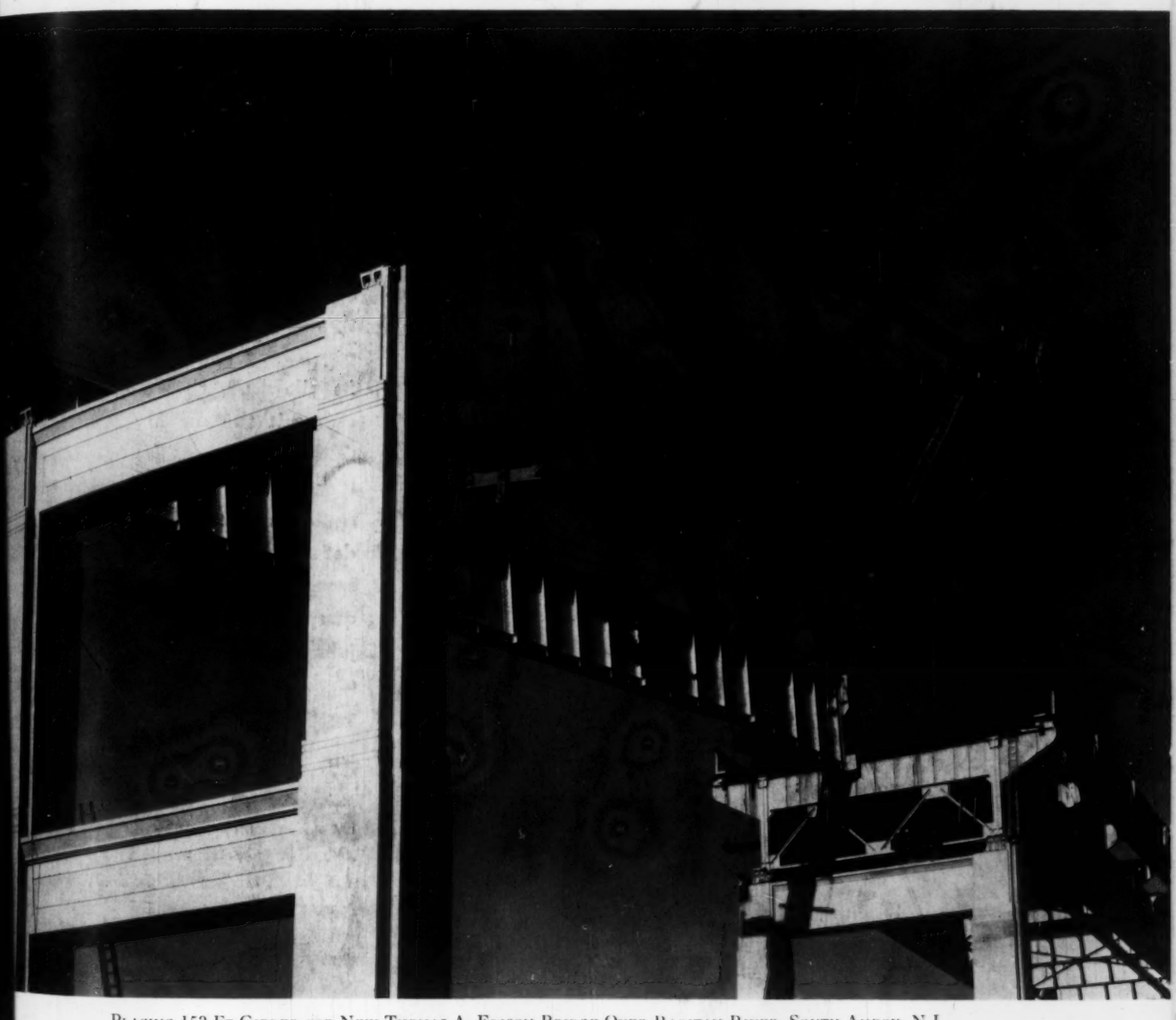

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Volume 10 — *Number 8*

AUGUST 1940

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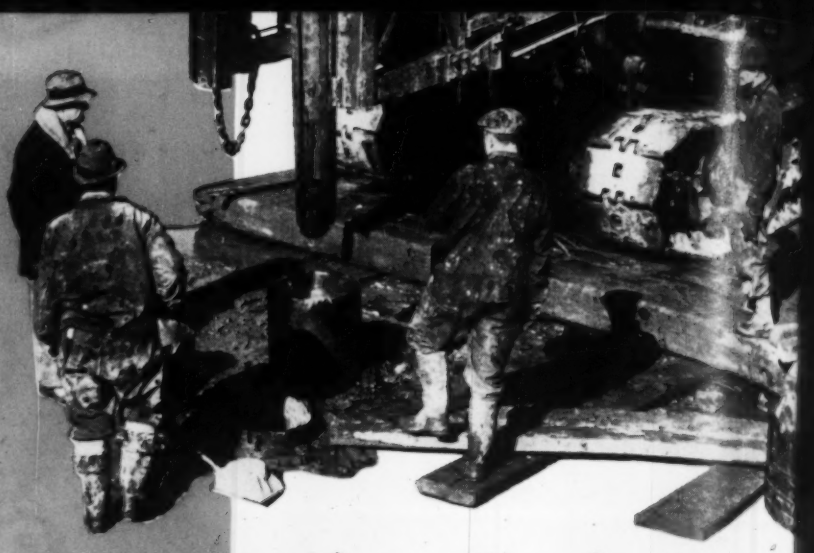

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Among Our Writers

EDWIN S. BURDELL was Dean of Humanities at M.I.T. for four years before going to the Cooper Union in 1938. His background includes an engineering education at M.I.T., 4 years in his father's bank in Columbus, Ohio, 4 years of European travel, and a Ph.D. in sociology from Ohio State U.

O. N. FLOYD (U. of Tenn., 1905) is frequently employed by contracting firms to help prepare bids on large dams and to advise on construction plant and operation. He is a consultant for TVA, and for the U.S. Army Engineers on Sardis, Wappapello, and other dams. From 1911 to 1922 he was with Morgan Engineering Co., most of the time on Miami Conservancy District work. Since then he has been mainly in private practice.

MORRIS GOODKIND (Columbia U., 1910) has been bridge engineer of the State Highway Department of New Jersey since 1925, and is also a consulting engineer. He received the Fowler Award in 1930 for College Bridge, New Brunswick, N.J. An A.I.S.C. first-place award went to his Shark River bridge in 1933, and two other bridges of his design have received A.I.S.C. honorable mentions.

A. B. CRAWFORD (D.V.M., George Washington U., 1914) entered the Bureau of Animal Husbandry on graduation, and in 1919 was detailed to the Bureau's Animal Disease Station, where he has conducted research on various diseases of cattle and swine.

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A. H. RINEY (U. of Kansas, 1911) during the war was a captain with the 28th Engineers in France. Since 1919 he has been with Phillips Petroleum Co. in charge of engineering and construction work on all types of petroleum projects, including over 3,000 miles of pipe lines.

STANLEY LEARNED (U. of Kansas, 1924) in 16 years with Phillips Petroleum Co. has "worked up" from member of a survey party to chief engineer. In 1930 he was in charge of the 681-mile pioneer gasoline pipe line from Borger, Tex., to East St. Louis, Ill.

EVERETT SCROGGIE has had a wide variety of problems in altering, raising, and repairing bridges to solve for TVA. Previous experience—practically all in bridge work—has been with the South Carolina State Highway Department, North Carolina Highway and Public Works Commission, and the Southern Railway Co.

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This Issue Contains

PAGE OF SPECIAL INTEREST—Steel at Work (*R. A. Wurgel Photo*) 5

SOMETHING TO THINK ABOUT
Developing Professional Competency 485
Edwin S. Burdell

MODERN CONSTRUCTION METHODS ON EARTH DAMS—Part I . . 487
O. N. Floyd

DESIGN FEATURES OF THOMAS A. EDISON BRIDGE 491
Morris Goodkind

EFFECT ON ANIMAL HEALTH OF FEEDING SEWAGE 495
A. B. Crawford and *A. H. Frank*

COAL FOR POWER GENERATION 497
C. Y. Thomas

GASOLINE PIPE LINES—DESIGN AND CONSTRUCTION 501
A. H. Riney and *Stanley Learned*

RAISING AND WIDENING CONCRETE BRIDGE IN CHICKAMAUGA RESERVOIR 505
Everett Scroggie

POLLUTION ABATEMENT IN NEW YORK AREA—THE CITY ITSELF . 508
R. H. Gould

PRELIMINARY ENGINEERING AT MORENCI OPEN PIT 510
Walter C. Lawson

ROGER SHERMAN, COLONIAL SURVEYOR 514
Edward Dyer Kingman

THE PECOS RIVER JOINT INVESTIGATION 516
Harlowe M. Stafford

LOW-COST ROADS IN KANSAS 520
R. B. Wills

MODEL STUDIES OF OVERFLOW SPILLWAY SECTIONS 523
A. S. Offitzeroff

ENGINEERS' NOTEBOOK
A Graphical Method for Land Subdivision Problems 526
Ray Kinslow

A Model Rigid Frame 527
Kenneth W. Dowie

Conversion of Units and Dimensions 528
C. J. Posey and *J. W. Howe*

OUR READERS SAY 529
SOCIETY AFFAIRS 534
ITEMS OF INTEREST 538
NEWS OF ENGINEERS 541
DECEASED 542
CHANGES IN MEMBERSHIP GRADES 543
APPLICATIONS FOR ADMISSION AND TRANSFER 545
MEN AVAILABLE 548
RECENT BOOKS 548
CURRENT PERIODICAL LITERATURE 10, 12, 15, 16
EQUIPMENT, MATERIALS, AND METHODS 18, 20, 21, 22
INDEX TO ADVERTISERS, ALPHABETICAL AND BY PRODUCT . . 19, 23, 24

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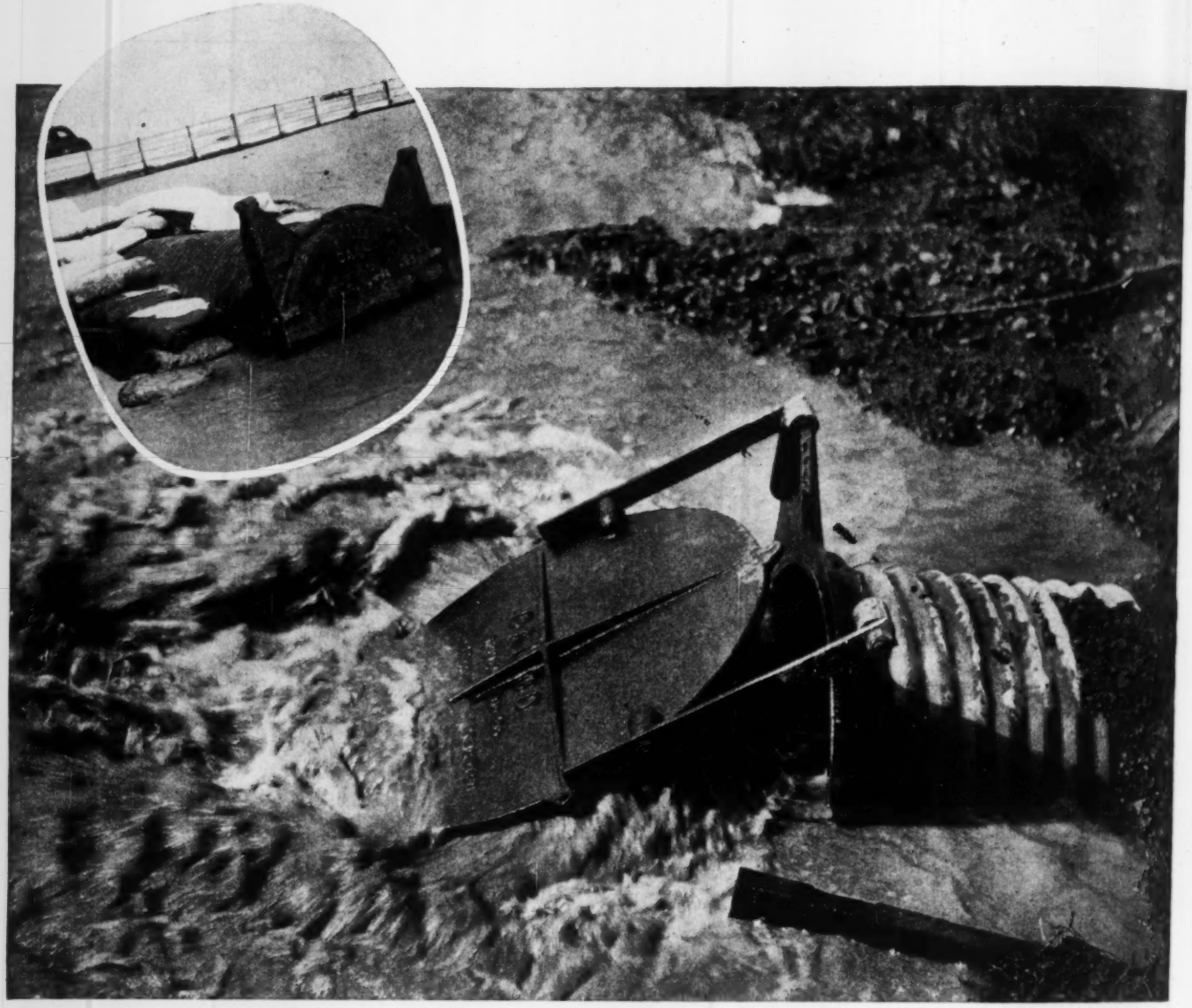

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Developing Professional Competency

Particularly as to the Engineering Schools' Share in This Responsibility

FROM AN ADDRESS BEFORE THE LAST ANNUAL MEETING OF THE ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

By EDWIN S. BURDELL

DIRECTOR OF THE COOPER UNION, NEW YORK, N.Y.

BUSINESS and industrial executives are becoming increasingly critical of the lack, in engineering graduates, of the flexibility that administrative responsibility requires. They have come to regard specialists who are limited both in capacity and performance as belonging to the category of technical assistants. The young engineer who has a good grasp of the fundamentals of his own field and who can talk and work intelligently in related fields is obviously better prepared to meet the demands of rapidly changing business and industry.

Demands from Outside.—Industry is becoming more scientific. Today the manufacturing processes rely on knowledge and on the use of the scientific laws underlying technology. Electronics, metallography, spectroscopy, the use of mathematics in determining a scientific sampling technique for quality control in mass production—these are a few of the scientific fields that redefine a technology in which formerly guesswork required huge factors of safety and in which uniformity of product was more dependent on uniformity of raw material than on any other single factor.

For this reason, engineering schools are offering much more basic instruction in science and mathematics and correspondingly less in the minutiae of engineering applications than they did formerly. Many industries prefer to teach detailed procedure in their own apprentice and practice schools.

Humanistic Studies, Also.—In addition, there is another criticism of engineers which is shared by large numbers of executives and which has its repercussions on the status of the engineer in modern society. It is held by many that the engineer has too narrow an understanding of the human society in which science and technology play so important a part. Reason tells us that young men little schooled in history and in the basic principles of human behavior, and with views on racial, economic, and political matters that are a composite of personal prejudice and current propaganda, are ill fitted to step into positions of leadership where calm judgment, understanding, and broadmindedness are required. Schools of engineering have sent out battalions of trained engineers, but few have shown the capacity to maneuver beyond the confines of the drill ground.

Regardless of whether such capacity is inborn or is capable of being developed, no doubt now remains that it is a responsibility of the engineering schools to offer subject matter that will develop the ability to think rationally and scientifically. The student must be able to grasp concepts which do not admit of the precise analysis, calculation, and control with which the physical scientist and engineer have been accustomed to work, and which have been hitherto the accepted limit of their knowledge and proficiency. Only an integrated study of the social sciences and the humanities will render our engineering students less susceptible to the prevailing shibboleths, clichés, and slogans regarding race, creeds, and political programs. The development of stereotyped thinking is swifter and less painful, but it is far more dangerous in these days when adaptability is necessary for survival.

Although in recent years many individuals have urged that engineering students be brought under the influence of such typical liberal arts subjects as the social sciences and the humanities, neither the profession as represented in the principal engineering societies, nor the schools, have been able to convince the general public that preparation for an engineering career consists of much more than the mastery of mathematics and the physical sciences. Nevertheless, promising beginnings have been made at a number of engineering schools, as at the Carnegie, Stevens, California, and Massachusetts institutes of technology. There are, of course, many thoughtful developments taking place in other institutions also. Some engineering schools located within universities rely on directing their students to specific non-engineering courses that are offered by other departments of the university.

Too Narrow Viewpoints.—Out of these varied approaches should evolve a sound educational plan to guide those who are already seeking ways of enriching their curricula and to act as a spur to the more conservative colleges which continue to relegate the humanities to an inferior status. However, the tendency of some engineering school faculties to insist on "Engineering English," "Engineering Economics," and the like, is to be deplored. There is, so to speak, only one English language, one economics.

Of course there are many "systems" of economics, upon which violent partisan views may be taken, but whichever one is chosen, its total effect on human life and society must be considered and not its limited relationship to the profession of engineering.

The emphasis should be placed on the fundamental elements of the subject and not merely on the superficial aspects that relate to engineering and industry. Without an understanding of the principles underlying the social sciences and humanities, a study of their applications is as superficial as a correspondence course on theodolites would be in comparison with a college course in civil engineering.

Combined, Not Separate Courses.—One questionable trend is the requirement of two years of liberal arts study for admission to an engineering school. To be sure, in a large university this two-year preparatory program may be properly articulated with the engineering program. The danger lies in assuming that a preliminary two-year immersion in a liberal arts atmosphere will necessarily have some permanent effect on the attitude and behavior of the engineering student four years later when he graduates and begins to practice his profession. The analogy with the preparation for law and medicine, which proponents of this plan advance, breaks down before the fact that professional training in these fields concerns itself directly with social and human material, whereas the physical sciences and their engineering applications concern themselves with human life and human values only indirectly.

Humanistic studies should be required throughout the entire four or five years of undergraduate schooling and should be taken concurrently with technical courses. As a rule the freshman needs most of all improvement in his mode of expression, both written and oral. He needs as well some history to orient himself in time and space. In the second year his interest should have been so kindled by the reading material in the freshman English course that he wishes to read more literature, to study more intensively scientific writing and thought, or to acquaint himself with the history of science and engineering. As he becomes more mature, the principles of economics, sociology, political science, and psychology make their appeal. He begins to want to know why people behave as they do, and the social sciences furnish reasonable and approximate answers. Finally, he is ready to consider certain philosophical concepts of man and his relation to his fellow men and the universe.

To separate the educational and training process into two years of non-technical studies and four years of technical studies is comparable to breaking down all color into black and white. To live is to act; to act is to choose; to choose is to evaluate. The student must be given the background for his evaluation through the acquisition of a personal social philosophy. He is not as likely to develop this in a detached program of pre-engineering study in the liberal arts, as in an integrated and well-thought-out scheme which embraces at the same time basic engineering instruction.

Complacency Should Be Condemned.—There are those who adopt a laissez-faire attitude and would do nothing about liberalizing the engineering curriculum. They comfort themselves with the thought that the alert young graduate will sooner or later find time to pick up a little reading in economics, labor problems, literature, and drama, and by these unguided and uninspired excursions in his spare time will assure his immediate usefulness as an engineer as well as his preparation for a rich and satisfying cultural life as an individual. Having heard this argument advanced many times, I have sought to ascertain to what extent engineering graduates five to ten years out of college have indulged in such self-improvement.

Inquiry has revealed that conscious effort in cultural fields is practically negligible. Some graduates turn to mail order courses in "personality" and "the art of dinner conversation"; others pick up crackpot economic schemes with a tinge of engineering content; still others are influenced by the propagandist advocating harebrained utopias. Alert young engineers do reach out for information and theory along economic and social lines, but without preparation and guidance they are quite as likely to work with superficial and specious, as with sound and authoritative, materials. Their helplessness is not unlike that of an undernourished youth who fails to get a healthful meal because he has no idea what constitutes the elements of a balanced diet.

Educators Use Scientific Approach.—There is ample evidence that training has been narrowed by too elaborate a provision for the first job, and that schools have failed to stir those interests which lead the graduating engineer to continuing study of science and society. Indeed there is good reason to believe that graduates tend to depend largely on the assimilation of day-to-day experiences as the basis for meeting new situations. The impasse that faces civilization today is not due to any lack of intellectual power. Rather it has arisen because we have attacked our problems by the wrong method, a method characterized by rule-of-thumb, last-minute expediency, and self-interest. The right method is the scientific method, which, if coupled with sensitivity to the human values of freedom and individuality, will save our civilization from the irresponsible technologist and the scheming politician. Scientific humanism, as the doctrine has come to be known, is the unfailing resource of a sane democratic state.

Practical educators not only are meeting the situation by solutions worked out by their own faculties independent of outside pressure, but are desirous of preserving this right of independent action for all other engineering faculties. Perhaps it is not going too far to say that the preservation of this right is part of the general struggle for the preservation of the democratic way against regimentation, or against what is worse—a philosophy of defeatism which surrenders to others that freedom of action which we alone should exercise.

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VOLUME 10 — AUGUST 1940 — NUMBER 8

Modern Construction Methods on Earth Dams—Part I

Relative Economy of Hydraulic and Rolled Fill; Pickwick Landing Dam Illustrates Use of Two Types in Conjunction

By O. N. FLOYD
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, DALLAS, TEX.

TODAY'S earth dam is both better and cheaper than that of a decade ago, says Mr. Floyd, largely because of improvements in construction equipment. New machinery, and new refinements in old machinery, are the order of the day for both rolled fill and hydraulic fill work. In a series of two articles, of which this is the first, Mr. Floyd reviews this progress for "Civil Engineering." The present paper deals largely with the construction of the Pickwick Landing Dam, while the one to follow will discuss the work at Sardis and Wappapello. Pertinent unit cost and performance data are included for all three projects.

PROBABLY in no field of heavy construction has greater progress been made during the past ten to fifteen years than in excavating, transporting, and placing the materials for earth dams, more especially for rolled fill dams. Fortunately this progress has resulted in the construction of better dams at a material reduction in the unit cost per cubic yard. Such improvements have been due, in part, to better facilities and ability to gain a more complete knowledge of the available materials through soil mechanics, but more to mechanical improvements in the design and construction of better earth-handling and rolling equipment. Conspicuous in the development of better earth-handling equipment has been the crawler tread tractor, the Diesel engine for tractors and trucks, the successful development of very large pneumatic rubber tires for carrying heavy loads at high speeds, and the sheepsfoot roller for compaction.

In the equipment for building hydraulic fill dams no particularly outstanding mechanical changes have been made. However, refinements in design and the use of high carbon welded steel dredge pipe and the more resistant alloy metals in pump shells, impellers, and cutter heads have greatly reduced the cost and delays for renewals and made higher average pump efficiencies possible. Some recent dams of very large volume have made it practicable to use larger and more efficient dredges for this type of work; and a more generally recognized need for abundant power for dredges for such work, to maintain high pipe-line velocities at all times and keep a heavy load of solids in suspension, has very materially increased the rate of output of solids and reduced unit costs.

As recently as fifteen to eighteen years ago, if a proposed dam had a total volume of around 2,000,000 cu yd or more and there was available suitable material for a hydraulic fill and enough water to float and operate a suction dredge, there was little question but that a hydraulic fill could be built more cheaply and, in general, more quickly than a rolled fill. If the hydraulic fill borrow was so located that it could be sluiced to a sump to be picked up by a stationary dredge pump, then the chance that a rolled fill could compete in speed and cost was even less than if a floating dredge had to be used.

Today, for a hydraulic fill to be cheaper than a rolled fill the proposed dam embankment must contain generally not less than 10 to 12 million yards and be located across a wide valley with good hydraulic fill borrow, at least 40 ft deep, available for almost the full width of the valley. In this case, even, a rolled fill would probably be the cheaper if the valley floor had suitable rolled fill borrow 10 to 12 ft above ground water; and if speed of completion were important the rolled fill could be placed as rapidly as could the hydraulic fill, with the additional consideration that the investment in the rolled-fill plant would be less.

EARLY STAGE OF HYDRAULIC-FILL CONSTRUCTION ON PICKWICK LANDING DAM

PRINCIPAL FEATURES OF PICKWICK LANDING DAM ARE, LEFT TO RIGHT, 1,000 FT OF EARTH EMBANKMENT (WITH SWITCH YARD ON FILL); POWER HOUSE; SPILLWAY SECTION; LOCK; AND 4,700 FT OF EARTH EMBANKMENT

With amply safe foundation material upon which to build an earth dam and with proper borrow material for each type of construction, there should be no particular advantage in safety or utility of one type over the other, but during construction the hydraulic fill is a little harder to control and can become dangerous if not properly handled. If the foundation material is lacking in stability, under the superimposed loads, a rolled fill of the same cross section will probably produce less strain on the foundation during construction than will the hydraulic fill. On the other hand, the actual cost of placing the additional material required for flatter slopes to avoid a base failure will not be great if a dredge is used for the main embankment. Where the available material for the dam embankment departs considerably from the ideal, as is often the case, it is much easier to control and keep within safe bounds a rolled fill than it is to get proper construction by hydraulic fill methods. A reasonable amount of excess clay can be wasted from the core pool without much trouble or expense, but to try to retain in the hydraulic fill embankment excess clay from the borrow areas by widening out the puddled core is always a dangerous practice. The wide core in itself would add no risk, but as usually constructed it is widened at the ground line and not at the top of the fill, making the side slopes so flat that a larger amount of the shell material rides vertically over them to become a part of the weight of the core, thus tending to push the toe of the shell out and create a slide or base failure.

At the present time there is available a wide assortment of efficient and dependable equipment for excavating, transporting, and placing the materials for earth dams, and a proper choice of the equipment for a particular job will depend on the size of the job, the nature of the material, the required length of haul, flood and ground-water hazards, and to some extent the amount and distribution of the annual rainfall and the climate. For instance, some equipment that is very satisfactory for this work in the drier regions of the West and Southwest is very poorly suited to conditions in the lower Mississippi Valley and the southeastern states, or in other places where the rainfall is greater and the sun shines less.

On most construction projects where a large dam is involved there are other considerations—such as the construction schedule arranged to take advantage of dry or low-water seasons and to minimize flood hazards, and the coordination with other features of the project—which must partly govern the choice of the excavating and earth moving equipment. In fact, on a large project almost no item of work can be handled as efficiently and cheaply as would be possible if that item were a job all by itself. The least cost and best progress for the job as a whole must govern schedules and choice of equipment, and this should be kept in mind in planning the construction of a project and in comparing unit costs of similar items on different projects.

BOTH HYDRAULIC AND ROLLED FILL AT PICKWICK DAM

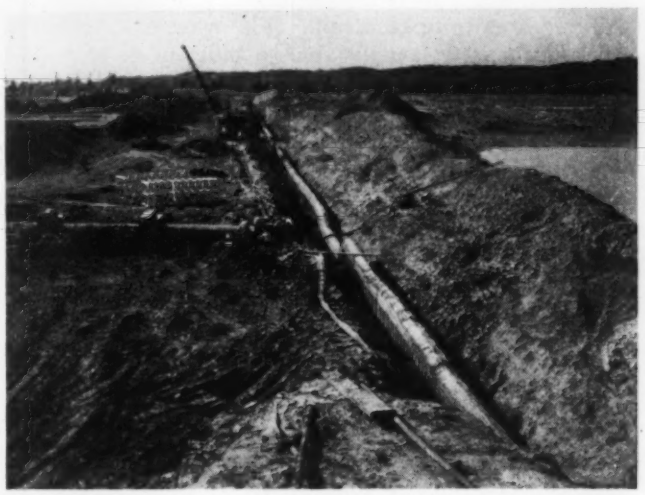
The Pickwick Landing Dam (across the Tennessee River about 53 miles downstream from the Wilson Dam) is a good illustration of a project where construction features and the schedule for the more difficult and expensive concrete structures exercised considerable influence on the schedule and the selection of the plant for the earth dam portion of the project. This project was started early in 1935 and finished in about four years by the Tennessee Valley Authority with hired labor under the direction of its own engineering and construction organizations. The principal features of the project are a gated concrete spillway across the main stream, a navigation lock at the left (south) end of this spillway set largely in the river bank, and a power house located just beyond the river channel at the other end of the spillway. Between the power house and the right abutment there is an earth dam about 1,000 ft long, and reaching from the navigation lock to the left abutment there is an earth dam about 4,700 ft long. For the most part each of these earth wings is about 45 to 50 ft high. Roughly, bed rock was close to El. 335, and the valley floor near the river on each side was near El. 390 and somewhat lower between the river banks and the abutments. Usually from about June to December, during construction, low water was around elevation 355. In order to avoid the early spring high waters as much as possible it appeared best to do the river work in three stages—that is, use three cofferdams. No. 1 included the lock; No. 2 the north, or right, bulkhead wall, power house, and about one-fourth of the spillway; and No. 3 the remainder of the spillway, reaching to the river-side lock wall.

CORE TRENCH ON AXIS OF PICKWICK LANDING DAM
In Background, Pile Driving Is in Progress; in Foreground, Forms Are in Place for Concrete Water Stop

The necessary earth excavation for the lock and its approach channels was about 1,670,000 cu yd. The dam embankment required on this south side of the river was 1,132,000 cu yd. The necessary excavation for the power house, including intake and tailrace, was 1,727,000 cu yd, and the required fill on that side of the river for dam embankment and switch yard was 1,578,000 cu yd. Besides the fill required for the dam and switch yard the three cofferdams required a total of 329,000 cu yd of fairly clean sand and gravel. Generally all the required

excavation, if mixed from top to bottom, constituted excellent material for a hydraulic fill. It had a little excess clay which could easily be wasted with the overflow water from the core pool. Aside from scattered boulders the maximum size gravel was about 3 in. This material was also suitable for a rolled fill, but nearly half of it lay below ground water, and records of rainfall and soil moisture indicated that it would probably be hard to do much on a rolled fill from late November to about May.

Estimates indicated that during favorable weather rolled fill could be placed more cheaply than hydraulic fill, but for filling the cofferdam cells and for excavating below water outside the cofferdams for the power-house intake and tailrace, and the approach channels for the lock, a dredge would be needed. The dredge and hydraulic fill operations would not be delayed by wet weather or by any but the larger floods in the river, and lock and power-house excavation could be done with the dredge without waiting for the cofferdams to be completed. It was decided to place most of the south earth dam (1,030,000 cu yd) hydraulically, the main dam embankment and a part of the switch-yard fill on the north side by dry excavating and hauling equipment, and the remainder



VIEW ALONG AXIS OF EARTH EMBANKMENT, SHOWING CONCRETE-CAPPED STEEL PILING CUTOFF

Dirt Piled near Trench Was Used for Backfill. In Right Background, Pipe Is Being Strung Out Along Upstream Dike in Preparation for Hydraulic Fill

of the switch-yard fill by dredge. The main dam embankment (304,000 cu yd) was spread and rolled with sheepsfoot rollers; and 612,000 cu yd of the switch-yard fill was hauled and spread in layers, being compacted simply by spreading the travel of the hauling equipment over it. The remaining 662,000 cu yd of switch-yard fill was placed hydraulically.

EQUIPMENT FOR HYDRAULIC FILL

A 16-in. second-hand dredge in good condition was purchased for the hydraulic fill work. The main pump was direct-connected to an 800-hp speed-controlled motor. This was less power than was desirable, but for the higher lifts and longer lines a booster would be required anyway. Later the main dredge pump and motor were duplicated for the booster. For the south-side work the booster was placed at the downstream toe of the dam on the edge of the second bottom about 1,800 ft from the river. This location later proved to be a mistake, because in much of the lock-approach channel excavation the pipe line between the dredge and the booster had to be so long and the friction head was so great that, with the static head, proper feeding of the line would develop an overload on the pump motor that could not be relieved by the booster. On the north or power-house side the booster was placed on a floating barge at the shore end of the floating line, and this proved to be a much more flexible arrangement which added materially to average hourly output.

All discharge pipe was of welded high carbon steel, with 16-in. inside diameter. The floating line was $^1/_2$ in. thick with ball joint couplings. The shore pipe was No. 8 gage spiral welded with slip joints, and two hooks were welded on near each end so that joints could be wired together. The maximum length of line on the south side was 5,165 ft and the minimum about 1,200 ft. On the north side the maximum was about 3,500 ft and the minimum about 1,000 ft. The net hourly rate of production for the best month was 330 cu yd per hour and for the lowest month 164 cu yd per hour, with an average for the job of 246 cu yd per hour. The net operating time for the job was 67% of the possible. It should be added that in excavating for structures the necessity for backing up frequently and sweeping the bottom so as to leave the rock as clean as possible was a handicap on the rate of production.

One of the surprises of this work was the abrasiveness of the material and the very short life of dredge-pump shells and impellers. The shell life ranged from 35,000 cu yd for high-carbon steel shells at the beginning to 261,300 cu yd for an improved-design nickel cast-iron shell finally adopted. For the impellers, best results were finally obtained from an improved design made of manganese steel. These impellers lasted for about the same yardage as the best pump shells. Also, considerable savings were made by designing shells and parts so that worn throat and side liners could be replaced quickly and discarded without the waste of unnecessary metal.

On the south side, where the dredge placed about 1,030,000 cu yd of hydraulic fill in the dam embankment, the total cost per cubic yard was divided as shown in Table I.

On the north side, the dredge fill was short and wide, with one side bounded by the previously built rolled fill, and pipe lines were generally much shorter than on the south side. Moreover, with no core required, higher lifts could be pumped per run of pipe. For these reasons the unit cost of dredging and placing was considerably less for this work.

For the entire 2,614,000 cu yd handled by the dredge on the Pickwick Landing job, the cost of the dredge operation, including depreciation but not including pipe line and placing expense or overhead, was $0.186 per cu yd. If the improved pump metal and designs worked out during the progress of the work could have been made available at the beginning of the job, it is likely that final costs would have been reduced by from 3 to 5 cents per cu yd. It is also likely that if the floating booster had been built at the start and used on the south side so that it would have been easily available every time the addi-

LOCK EXCAVATION WENT DIRECTLY INTO HYDRAULIC FILL AT PICKWICK LANDING

tional power was needed, unit costs could have been reduced by from 1 to 3 cents per cu yd for the hydraulic fill on that side because of better average rate of output.

OPERATIONS ON THE ROLLED FILL PORTIONS

On the south side about 100,000 cu yd of rolled fill was placed in two end dikes for the hydraulic fill and in the backfill or short section between the north end of the hydraulic fill and the land lock wall. The time of placing

ELEVATING GRADER AT WORK ON THE INTAKE EXCAVATION

this rolled fill had to be adjusted to the progress of the other work, with frequent interruptions, and considerable unfavorable weather was encountered. The excavation and loading were done mostly by a power shovel, but a small part was done with an elevating grader. The hauling was by trucks and wheeled-tractor-and-truck

TABLE I. HYDRAULIC FILL COSTS, PICKWICK LANDING DAM (SOUTH SIDE; 1,038,664 CU YD)

ITEM	COST PER CU YD
Dredge Operation:	
Superintendent and operating labor	$0.036
Power	0.022
Supplies and small tools	0.012
Repairs, field labor, parts, shop orders, etc.	0.103
Blasting and sloping bank	0.007
Depreciation	0.049
Total—dredge operation	0.229
Distributing Material—total pipe-line operations, including depreciation	0.060
Booster Pump Operation (based on total yardage):	
Operating labor	0.005
Power	0.010
Supplies, small tools, and repairs	0.016
Depreciation on pump	0.018
Total—booster pump operations	0.049
Levee Building and Forming Slopes:	
Field labor, draglines, etc.—on slopes and levees	0.040
Outlet and Drainage Facilities for Core Pool	0.012
Total cost	0.390*

* $0.229 of this unit cost is properly chargeable to lock excavation and $0.161 to hydraulic embankment fill. This cost division is justified, since if the operation had been only to secure fill some of the necessary material would have been more readily and cheaply available from other sources.

units. The total cost per cu yd was 45.0 cents, divided as follows: excavation, 13.7 cents; hauling, 16.1 cents; and placing and rolling, 15.2 cents.

On the north side 304,000 cu yd of rolled fill in the dam embankment and about 200,000 cu yd of common fill in the switch yard were placed by dry-excavating and hauling equipment under very favorable weather conditions from June to November. All this fill came from the excavation for the power house, power-house intake, and tailrace. Generally about 2 ft of top soil was stripped off, and then the fill material (clay and sandy clay) was excavated down to where it became too wet for dry methods because of nearness to ground water. The excavating was done by an elevating grader pulled by a 75-hp crawler-tread tractor. (Near the bottom of some of the excavation, where the material was wet, two tractors were used to pull the grader.) Occasionally when the elevating grader was down for repairs, a dragline was used. In the beginning four 8-cu yd wheeled-tractor-and-truck units were used for hauling. Later, as the haul became longer and the lift greater, two more similar units were added, but the sixth was rarely needed except as a spare when a unit was down for repairs. A 60-hp tractor, a road grader, and a heavy timber drag were used to keep the roads and borrow area in shape for rapid truck travel. A 75-hp tractor and bulldozer helped on roads, and on spreading on the fill. Also on the fill were a 50-hp tractor and bulldozer, two units of two sheepsfoot rollers in tandem, each drawn by a 60-hp tractor, a heavy harrow, and a team-drawn sprinkler.

Generally the material was wet enough, or too wet, so that the sprinkler was used very little except on places of concentrated travel where the surface became smooth, hard, and dry. It was found that lost time after rains could be materially reduced (1) by keeping the surfaces of the embankment and the excavation pit sloped so they would drain, and (2) by rolling all material on the fill and bulldozing the bottom of the pit over the working area prior to a rain. The wheeled-tractor-and-truck units were usually able to pull out of the softest places in the borrow pit without serious delays, and on the embankment the dumping was so handled most of the time that they could turn on a long radius and dump at 10 to 15 miles per hour.

Later, from March to May, four 8-cu yd wheeled-tractor-and-truck units, loaded by a heavy-duty dragline using a $2^1/_2$-cu yd bucket, handled 110,000 cu yd into the dam embankment and switch yard under very unfavorable weather conditions. Also, from December to June, four 12-cu yd carrying-type scrapers, each pulled by a 95-hp tractor, handled 256,000 cu yd into this fill from the power-house intake and tailrace. Unfavorable weather and the high moisture content of the material in the pit were a considerable handicap to this work.

The costs, progress, length of haul, and other pertinent data on earth-moving operations at Pickwick Landing Dam (north side) are summarized in Table II:

TABLE II. EARTH-MOVING DATA, PICKWICK LANDING DAM (NORTH SIDE)

Date	June–Nov. 1935	Dec. 1936–June 1937	March–May 1937
Cubic yards of earth	503,425	255,565	109,935
Hauling equipment	6 wheeled-tractor-and-truck units	4 95-hp tractors 4 12-CY scrapers	4 wheeled-tractor-and-truck units
Loading equipment	Tractor-drawn 48-in. elevating grader	....	Heavy-duty dragline with $2^1/_2$-cu yd bucket
Average cubic yards per net operating hour per unit	41.4	31.9	37.0
Average loads per net operating hour per unit	7.4	5.8	6.5
Average cubic yards per load	5.6	5.5	5.7
Average haul (ft)	1,200	900	886
Cost per cubic yard	$0.118*	$0.204*	$0.230*

* Generally the spreading, rolling, road work, extra tractor service to help hauling equipment out of soft places in the pit, and other miscellaneous services, added about 6 to 8 cents per cu yd of embankment to the costs given here; however, these costs varied with the weather and with increasing lift and are not available as an exact cost per cubic yard of embankment in place.

The writer wishes to acknowledge gratefully his indebtedness to T. B. Parker, chief engineer, Tennessee Valley Authority, for generously furnishing reports, photographs, and other information for the preparation of this paper.

Design Features of Thomas A. Edison Bridge

Structure Over Raritan River Relieves Traffic Obstruction on New Jersey Shore Route

By Morris Goodkind

Member American Society of Civil Engineers

Bridge Engineer, State Highway Department, Trenton, N.J.

One of the major highway readjustments of the day was demanded by the inadequacy of previous facilities for crossing the Raritan River between Perth Amboy and South Amboy. This is on the heavily traveled route between the metropolitan area and the New Jersey shore resorts. Economy dictated a high-level, fixed structure. Its outstanding feature is a series of continuous girders as main supporting members, varying in length up to 250 ft. Problems of traffic, foundations, and structural design are treated here; a later paper will cover construction.

One of the most heavily traveled highways in a state which is replete with dense traffic is that serving the Jersey shore resorts and known as State Highway Route No. 4. This connects (Fig. 1) with Route 25, the New York City–Philadelphia superhighway, at the Woodbridge cloverleaf. From that point south to the northerly communities on the Atlantic Coast, ever-increasing summer travel has created an almost intolerable traffic congestion; vehicular flow was bottle-necked at the Victory Bridge across the Raritan River as well as on its north and south approaches.

A few years after its completion in 1925, the Victory Bridge, with its 38-ft roadway and draw span providing a 28-ft vertical clearance in the closed position, became inadequate to meet the requirements of the increase of navigation on the river and of travel to the Jersey shore. This condition was aggravated by the need for traffic control at the intersections in Perth Amboy on the north approach and South Amboy on the south. At present, in the distance of 5 miles between the Woodbridge cloverleaf and the Victory Bridge, there are 11 traffic signals and 69 cross streets. The effect of these obstructions on the flow of traffic may be realized from the following data:

Average daily traffic in June, July, August 1938	=	31,202
Average daily traffic in June, July, August 1939	=	35,143
Peak traffic per month (August 1939)	=	1,095,738
Peak traffic per day (August 6, 1939)	=	58,499
Peak traffic per hour (4 to 5 p.m., August 6, 1939)	=	2,936

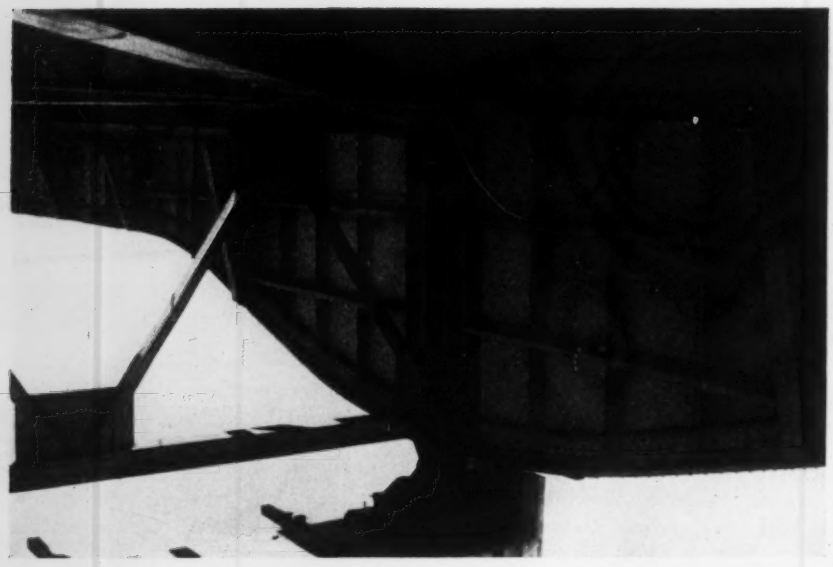
Also, during 1939 there were 2,979 openings of the draw span with a consequent loss of 275 hours, most of which occurred, unfortunately, during the summer months.

Lack of funds made any serious effort to relieve these conditions impossible until 1937 when $1,000,000 was budgeted to cover the cost of the first contract involving the construction of the river piers of a new bridge. Previous to this, however, improvements had been authorized to the approaches on the north and south to accommodate the new bridge: this road, known as Route 35 Extension from the Woodbridge cloverleaf to Keyport, is now complete and provides an express highway without intersecting traffic. In August 1938, with the aid of a grant of 45% of the total cost by the Public Works Administration, funds were made available to construct the new bridge, which will cost about $4,000,000. The first contract was let in September 1938.

Designated by the state legislature as the Thomas A. Edison Bridge, the new structure is located about 3,000 ft upstream from the Victory Bridge. Requirements of highway traffic made a fixed structure advisable, and those of navigation and the War Department determined the vertical clearance at the channel span as 135 ft at mean high water, with a horizontal clearance of 200 ft. The skew angle between the center line of the highway and the channel made it necessary for the channel span to be 250 ft from center to center of bearings.

Based upon borings taken throughout the length of the structure, economic conditions fixed the type of structure and lengths of the various spans. The total length of the bridge is 4,386 ft. On the north side of the river there are 6 spans of 152 ft 6 in., and 6 spans of 84 ft 6 in., all simply supported. On the south side there

Thomas A. Edison Bridge—Main Channel Span and Flanking Spans in Place, Looking Upstream (West)
Pier Numbers, From Left, 7, 8, 9, 10; Pier 1N Is Just Outside Photograph on Right



CLOSE-UP OF HAUNCH OF 250-FT SPAN GIRDER. MAXIMUM DEPTH OF GIRDER OVER PIER IS 21 FT 1¼ IN.

are 8 simple spans of 132 ft 6 in. The main spans across the river are nine in number and consist of one 250-ft span across the channel and 8 spans of 200 ft.

The roadway is 52 ft wide, with two emergency footwalks each 2 ft 1½ in. wide. These are protected by railings made of structural steel shapes adequate to withstand specified design loads, substantial in appearance, and at the same time offering a minimum of obstruction to the view of the motorist. The roadway will be divided into five lanes controlled by traffic-signal units mounted on overhead catenaries. The four outer units will be of the one-section, two-way type showing green to approaching traffic and red to opposing traffic; the middle unit will be of the two-section, two-way type so that it may be operated for the benefit of northbound or southbound traffic as conditions require. Normal morning traffic is almost entirely southbound, whereas in the evening the direction is reversed. By means of the flexibility provided by the traffic signals, three lanes will always be available for the heavy traffic. The entire bridge is of deck construction, thereby eliminating all structural hazards to traffic.

LOADING CONDITIONS ASSUMED

In addition to the actual weight of the structure, the following loads were used in the design:

Live load per traffic lane: Two 20-ton trucks preceded and followed by a uniform load of 720 lb per lin ft. This load is approximated by a uniform load of 720 lb per lin ft over any portion of this structure plus a concentrated load of 35,000 lb for shear and 25,000 lb for moment in the design of the girders.

Wind loads: 50 lb per sq ft on the unloaded structure acting transversely, longitudinally, or diagonally.

For transverse wind, the exposed area is taken at 1½ times the vertical projection of the structure.

For longitudinal wind, the exposed area is taken as ½ the area of all floor beams, brackets, and exterior girder stiffeners.

For diagonal wind, the transverse and longitudinal components are assumed at 90% of the maximum.

Wind in combination with live load is taken at 15 lb per sq ft plus an allowance for tractive force of 10% of the live load on two traffic lanes.

On the south approach the substructure consists of an abutment and seven piers. The abutment is of a U-type with the footing placed in the road embankment and supported on concrete piles bearing a maximum load of 30 tons. Since the embankment had been placed and compacted some time before the abutment was constructed, the economy and suitability of this design is self-evident. The piers are designed as one-story frames on a continuous footing founded on a compact gravel and clay stratum. The maximum pressures on these foundations are 3¼ tons per sq ft from dead, live, and quartering wind loads.

A similar arrangement of substructure is made for the north approach except that there are 11 piers. With the exception of Pier 1N, nearest the river, all these piers and the abutment have spread footings founded on a stiff clay, with maximum pressure from dead, live, and extreme wind loads of 3 tons per sq ft. Pier 1N required the use of timber piles because of the presence of river mud and refuse for a considerable depth below ground. These piles have a maximum load of 23 tons for dead, live, and extreme wind loads. Piers 1N to 4N, inclusive, are designed as two-story frames whereas the remainder are one-story frames.

For the main portion of the bridge across the river, the substructure consists of 10 piers. Borings taken throughout this section indicated depths of river mud ranging from 40 to 60 ft, underlain with sand and clay strata until trap rock was reached at depths of from 60 to 90 ft. All these piers are founded on this ledge, located so as to give span lengths consistent with the require-

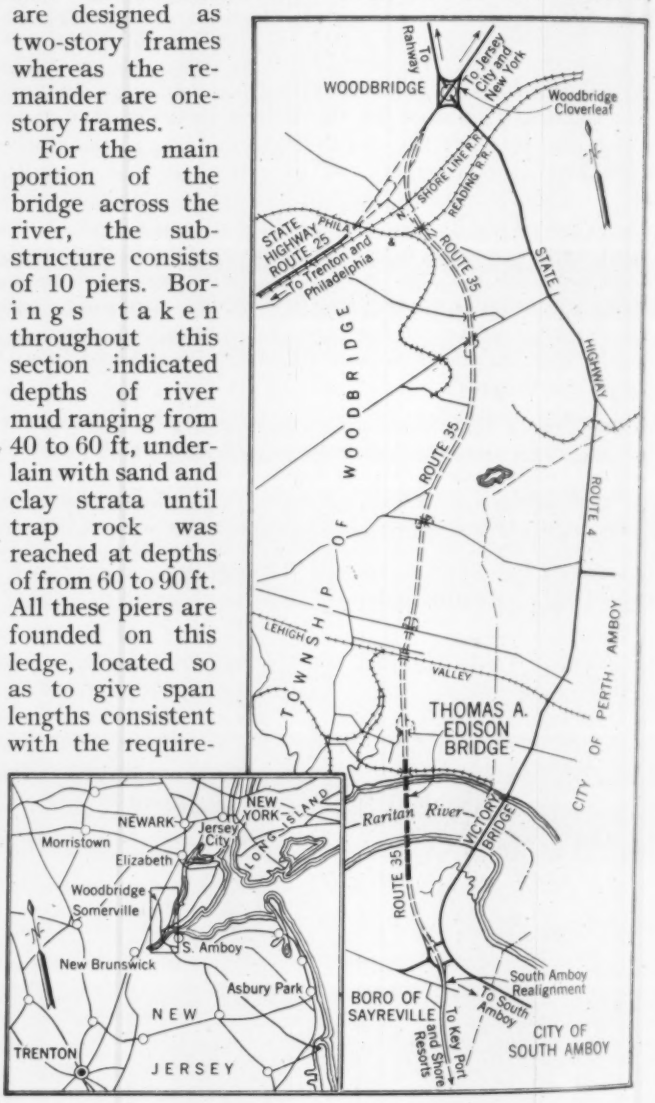


FIG. 1. LOCATION AND ROUTE MAPS OF NEW CONSTRUCTION, WOODBRIDGE TO SOUTH AMBOY, N.J.

ments of economy and the harmonious appearance of the structure as a whole. The specifications provided for the sealing of these piers under air, permitting either pneumatic or open dredging methods for sinking the caissons.

The nine spans across the river are arranged in three units of three continuous spans each, and the fixed bearings are located at Piers 2, 5, and 8, all other bearings being of the expansion type. The fixed piers are therefore designed not only for the dead and live loads imposed on them, but also for the most adverse conditions of wind loading over three continuous spans, and the effects of the maximum variations in pier location permitted by the specifications. The maximum foundation pressure occurs at Pier 8, amounting to 24 tons per sq ft and based on the assumption that the wind loads are carried by the pier down to the foundation with no allowance for any support which the material overlying the rock may afford. This pressure is well within the capacity of the foundation material. The ratio of the resisting moments about the edges of the bases to the overturning moments resulting from longitudinal wind is in each case about 1.9.

PIERS SUPPORT NOVEL PLATE GIRDERS

Up to El. −5.0 the river piers are solid, with pedestals above that point to El. +10.83; on these, in turn, are mounted two-story reinforced concrete frames extending up to the bridge seats. The pedestals are faced with granite, pointed with lead, as a protection against sea water, ice, floating debris, and chemical pollution of the river. In dimensioning the piers, due consideration was given to their proportions in relation to the superstructure, as well as to the actual structural requirements.

Perhaps the most novel feature of the entire bridge is the choice of plate girders for its main members. War Department requirements called for a channel span 250 ft long with a vertical clearance of 135 ft. This therefore became the focal point of the entire construction, and whatever was used in approaching this span was subordinated to it.

A bridge crossing is merely a highway supported on structural members instead of directly on earth. Hence we have always considered deck construction a most valuable asset to highway bridges. The attention of motorists should not be distracted by the carrying members, or worse still, by parts of the carrying members protruding above the deck. This ideal cannot always be met because of physical or economic reasons, but in the Edison Bridge no such restrictions existed.

Studies were made of the relative costs of truss construction and plate-girder design, taking into account the possibility of longer spans for the former. The saving in the case of the girder design has been variously estimated at between $150,000 and $300,000. Regardless of the saving in cost, the choice made was influenced also by the advantage in simplicity of the girder over the truss, the opportunity for graceful treatment of the girder, and the ease and assurance with which it can be properly maintained.

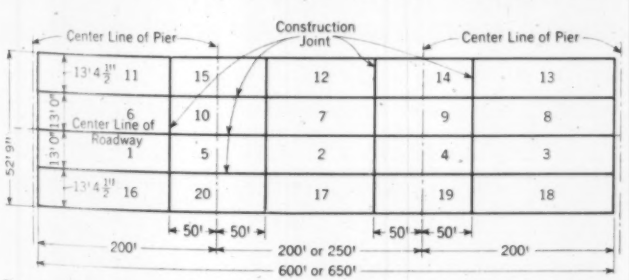


FIG. 2. PLAN OF BRIDGE FLOOR SLAB SHOWING PLACING SEQUENCE
Sidewalk of Sections 11, 12, and 13 to Be Placed Before Roadway Sections 14 and 15; Opposite Sidewalk to Be Placed Similarly

OBLIQUE VIEW—TYPICAL RIVER PIER

A comparison of the relative costs of carbon and silicon steel showed no difference, and carbon steel was chosen because of its lesser deflections and greater stability. The webs of the girders are 150 in. deep through the middle sections and 180 in. deep over the piers, excepting at the ends of the 250-ft span, where they are 246 in. The out-to-out depth of girder at these points is $253\frac{1}{4}$ in.

Depths for the girder were chosen so that the maximum deflection under live load would be relatively low and so that the required flange area might be provided without the use of an excessive amount of cover plates. The flanges are built up in the shape of a vertical "I" and consist of four 8 by 8 by $\frac{7}{8}$-in. angles with cover plates 26 in. wide. This arrangement gives a favorable distribution of flange material and moderate rivet grips. In addition, it offers an appreciable reduction in the use of fillers and makes for a better connection between flange and web. Another advantage lies in the bold appearance of the flange, which is so necessary in a girder of great depth and at such a height. The web plates were analyzed for shearing stresses, maximum diagonal stresses, and buckling strength. Elastic stability is provided by vertical stiffeners throughout and horizontal stiffeners at the ends of the spans where the depths require them.

The floor system consists of floor beams framed to the girders at 25-ft intervals, the top flanges of each being practically flush and the bottom flanges connected by knee braces. These braces transfer the wind loads to a lateral system in a plane at the bottom of the floor beams, which in turn transfer these loads to a cross frame over the piers. The knee braces also stiffen the bottom flanges of the girders where they are under compression, the top flanges being similarly supported by the floor beams and the concrete slab resting directly on it.

Part of the roadway and the footwalks are carried on brackets connected to the girders and floor beams. The stringers are framed into the floor beams and made continuous over each three-span unit. This continuity of stringers results in a reduction of the section required; but primarily it was adopted to eliminate possible cracking of the deck slab at the panel points, since the slab is supported directly on the stringers and is to be poured without the use of joints over the floor beams. To reduce the tendency for horizontal bending of the floor beams due to changes in length of the top flanges of the main girders under dead load, stringer lengths were chosen to conform with the actual distances between floor beams, as determined by the deformation of the girders with all steel in place.

DETAIL OF FLOOR SYSTEM

SHOP ASSEMBLY OF THREE-SPAN UNIT ASSURES PROPER FIELD ERECTION

Several methods were considered for assuring that the continuous girder stresses would conform substantially with the design values. The adjustment adopted is one offering simplicity and economy and reasonable assurance that the design stresses will obtain. It involves the complete assembly of a three-span girder unit in the shop. All sections of this unit are placed in correct relative vertical position as measured from a base line, and the field splices are then reamed. The angular movement at the field splices during erection was compensated by adjusting the traveler position after a pair of adjoining girders were in place and the splice was riveted with the holes perfectly matched. The variation of the actual from the design stresses by this method should be negligible if proper care is exercised in setting the bridge seats to correct elevation. In view of the possible limitations in some fabricating shops for assembling such long units, the specifications permitted the complete assembly of two spans plus the additional length to the field splice in the third span, provided the remainder of the third span was reassembled with the second span to accomplish the same results.

Expansion bearings are provided with segmental roller nests, which are enclosed in a housing filled with grease, proper precautions being taken to avoid the entrance of water. An inspection walk, hung from the floor beams throughout the length of the structure, is accessible through manholes in the deck and by ladders at each pier. This walk is of considerable value in each stage of the construction of the superstructure, and will serve for maintenance painting and repairs.

Supporting the concrete deck directly on the stringers, main girders and floor beams, causes the slab to participate in the bending moments of the girders by reason of the bond between the concrete and the top flanges. This bond will restrain the free movement of the slab and set up large shrinkage stresses in it. For the simple spans, this slab participation will produce compression in the slab, thereby reducing the tension resulting from shrinkage. The same effect will obtain in those regions of the continuous spans which are subject to positive bending moments. In the areas adjacent to the intermediate piers, however, the participation of the slab in the girder moments will produce tension in the concrete which when added to the tension resulting from shrinkage may approximate the ultimate tensile strength of the concrete, with the possibility that transverse cracks will develop.

A careful study of these conditions and their possible effects, especially in relation to the continuous spans, resulted in the following provisions:

1. Addition of rivets connecting the cover plates to the flange angles, if and where necessary, at the ends of the three-span unit, at construction and contraction joints, and over and adjacent to the intermediate piers where shrinkage cracks might develop, to avoid overstresses in the rivets resulting from shrinkage and slab participation in the girder stresses.
2. Adoption of a sequence of pouring the slab (Fig. 2) for a three-span unit to avoid the development of transverse cracks over and adjacent to the intermediate piers immediately after the slab is completed. This sequence provides for the placing of the slabs in the regions of positive bending moment of the spans in advance of the strips over and adjacent to the intermediate piers.
3. Reduction to a minimum of the number of transverse joints in the slab of a three-span unit to keep at a minimum the areas of contact between slab and girders where high bond stresses and rivet shears might occur as a result of slab shrinkage.
4. Use of details to assure continuity of stringers across the floor beams.
5. Addition of longitudinal reinforcement in the slab where tension produced by shrinkage, participation in girder stresses, and vertical loads make it necessary.

PREFABRICATED REINFORCING AIDS CONSTRUCTION

To assure a dense concrete and a satisfactory riding surface, standard road-paving equipment and methods were used. To facilitate the application of this requirement, prefabricated truss reinforcement was called for, and these trusses were welded to the structural-steel floor system and to each other through longitudinal bars. This arrangement makes it possible to use the reinforcement system as a riding surface for equipment by the addition of plank runways.

In the erection of the Thomas A. Edison Bridge these various design precautions were found to be more than justified. This was proved by the experiences of construction, which will be covered in a later paper.

Effect on Animal Health of Feeding Sewage

Swine and Cattle in Severe Six-Month Test Remain in Good Condition; Feedings Include Raw Sewage, Treatment Plant Effluent, and Sludge

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and A. H. FRANK

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WHEN the Beltsville Research Center was established at Beltsville, Md., in 1935, to combine several of the experiment stations of the U.S. Department of Agriculture, a treatment plant was provided to take care of the sewage of various units. This plant is of the trickling filter, separate sludge digestion type, with facilities for adding chlorinated copperas and lime and for pre-chlorination and post-chlorination. The units are a coarse bar screen, grit chambers, flocculating tanks, primary settling tanks, trickling filters, final settling tanks, separate sludge digestion tanks, glass-covered sludge-drying beds, chlorinators, and chemical dry-feed machines.

INFLUENT HIGHLY CONTAMINATED

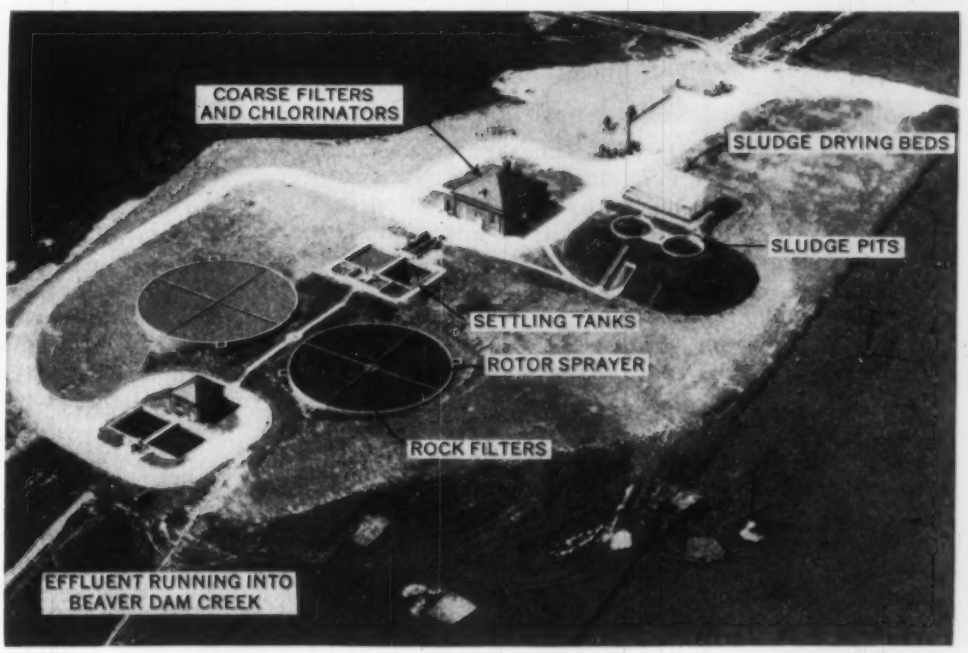
The sewage entering this system contains not only the usual contamination from human sources but also contamination from animals used in experimentation. At the Animal Disease Station (one of the units of the Center), tuberculosis, brucellosis of cattle and swine, infectious anemia of horses, equine encephalomyelitis, mastitis of cattle, hog cholera, swine erysipelas, vesicular stomatitis, and other bacterial and virus diseases are studied. Many of the stables and barns in which these diseases are studied are provided with septic tanks in which the sewage is disinfected, but the causative agents of these diseases in virulent form may pass at times into the sewage entering the treatment plant from the laboratory or from the post-mortem room where autopsies are performed on diseased animals. In several of the other units in which experiments are conducted on normal animals, outbreaks of disease sometimes occur and the sewage from those units is undoubtedly contaminated with the causative organisms.

In 1935 an outbreak of tuberculosis of unknown origin occurred in a herd of 387 cattle of the Bureau of Dairy Industry Experiment Station, another unit of the Center. This was before the treatment plant was placed in operation. In spite of control measures, tuberculosis has persisted in this herd and the suspicion was aroused that the treatment plant might be a factor in the continued spread of the disease through the medium of wild life, as birds had been observed removing floating particles from the margin of the settling tanks. The possibility of disease being spread to animals having access to the effluent of sewage disposal plants has been brought to the attention of sanitary engineers in many instances as a result of lawsuits against municipalities by stock owners who have claimed that the health of their animals was impaired through contact with the effluent from sewage disposal systems.

In January 1938, at a meeting of the various officials of the interested units of the Beltsville Research Center and officials of the Bureau of Agricultural Engineering, who constructed the treatment plant, it was proposed that a test be made of the incoming sewage, the effluent, and the sludge of this plant in order to determine whether disease-producing bacteria or viruses might be present in any of these elements. The proposed test was to be conducted in the following way. Incoming sewage and effluent were to be collected in sterile 5-gal containers thrice weekly and sludge was to be obtained each time the sludge pit was emptied, or about every six weeks. All three of these materials were to be fed to swine, and effluent only to a group of bovine animals.

PROCEDURE OF THE TESTS

On February 18, 1938, 18 healthy swine, weighing between 45 and 85 lb, each shown by test to be free from tuberculosis and brucellosis, were divided into three groups of six animals each. Six hog pens were cleaned and disinfected and three swine were placed in each pen. Pens 1 and 2 housed the swine to be fed incoming sewage (Group 1), Pens 3 and 4 swine to be fed effluent (Group



AIR VIEW OF SEWAGE TREATMENT PLANT AT BELTSVILLE RESEARCH CENTER

2), and Pens 5 and 6 swine to be fed sludge (Group 3). In March 1938, two cows and two yearling steers, previously proved by tests to be free from tuberculosis and brucellosis, were placed in a field remote from other animals. Each cow had a week-old calf by her side.

On April 4, 1938, feedings were started. Materials were collected from the disposal plant Mondays, Wednesdays, and Fridays of each week until October 4, 1938, a period of six months. On each of these days 5 gal of

GROUP OF SWINE IN FEEDING EXPERIMENT

incoming sewage were mixed with bran and fed to swine in Pens 1 and 2, and 5 gal of effluent were mixed with bran and fed to swine in Pens 3 and 4. On April 4, 5 gal of sludge were obtained, and about 2 quarts were mixed with bran and water and fed three times weekly to swine in Pens 5 and 6 until the material was exhausted. Fifteen gallons of effluent were obtained on Mondays, Wednesdays, and Fridays during the six-months' period and emptied into the water trough in the field where the cattle were kept. No other water was provided until each batch was consumed. None of the animals in the experiment manifested an unwillingness to consume the various materials. A laborer who had contact with no other animals during the period of the experiment was provided to make these feedings. During the six-months' period each swine in Group 1 received approximately $67\frac{1}{2}$ gal of incoming sewage; each swine in Group 2 approximately $67\frac{1}{2}$ gal of effluent. Only two batches of sludge were provided, so only about 20 feedings of sludge were made. A total of 1,215 gal of effluent were fed the bovine animals, most of which was consumed by the four adults. It was estimated that each adult received in the neighborhood of 275 gal of effluent.

WEIGHT RECORDS AND POST-MORTEMS

Each animal was weighed four times during the course of the feeding and the individual weights are shown in Tables I and II. During the five-months' period from May 1 to October 1 the swine in Group 1 (incoming sewage) gained 893 lb; swine in Group 2 (effluent) 790 lb; and swine in Group 3 (sludge) 814 lb. It would appear that a slight inhibition to gain was shown in Group 2.

TABLE I. WEIGHTS, IN POUNDS, OF FOUR BOVINES FED EFFLUENT

BOVINE NO.	APR. 3, 1938	JUNE 1, 1938	AUG. 1, 1938	OCT. 1, 1938
1,899	900	925	810	895
2,002	660	695	585	640
2,146	358	425	368	445
2,147	430	550	545	615

The swine in these tests were not of uniform weight at the start of the experiment and moreover some were of larger breeds than others. It is not felt that the experiment was sufficiently controlled to incriminate the effluent as having any effect on the normal increase in weight in the animals in Group 2.

It will be noted from Table I that each of the bovine animals showed a loss of weight on August 1. Whether this was due to the summer heat and a relatively poor diet is not known. At no time, however, did they show any indication of sickness or loss of appetite.

Tuberculin tests were made of swine and cattle on June 6, August 11, and October 4, 1938, and none showed a reaction indicative of infection. At no time during the period of feeding did any of these animals show loss of condition or any indication of disease.

In order that any disease condition might have ample time to develop after the feedings were discontinued on October 4, all animals were kept in the same pens for a further period of six months. All remained uniformly well during this period. On December 1, 1938, and March 13, 1939, all animals were retested with tuberculin but none showed a positive reaction. Starting March 15, 1939, 1 to 3 swine were killed daily and a careful post-mortem examination was made of each carcass. No evidence of disease was observed. All animals were in apparently prime condition. Samples of blood obtained from the swine at time of slaughter were tested for brucellosis but none showed a positive reaction.

The four older cattle were killed between March 29 and April 4 and a careful post-mortem examination was made of each. These animals were in good condition and showed no evidence of disease with the exception of Cow 2,002 in which calcareous, parasitic lesions were

TABLE II. WEIGHTS, IN POUNDS, OF SWINE FED INCOMING SEWAGE, EFFLUENT, AND SLUDGE

GROUP NO.	SWINE NO.	WEIGHTS			
		May 1, 1938	June 1, 1938	Aug. 1, 1938	Oct. 1, 1938
Group 1 (fed incoming sewage)	4,867	157	224	315	350
	4,868	127	169	220	240
	4,869	150	199	262	295
	4,870	109	162	226	275
	4,871	163	222	271	295
	4,872	131	173	239	275
Total weights		837	1,149	1,533	1,730
Group 2 (fed effluent)	4,873	73	102	167	215
	4,874	117	163	219	230
	4,875	167	213	264	275
	4,876	99	142	196	225
	4,877	90	135	218	245
	4,878	104	149	230	250
Total weights		650	904	1,294	1,440
Group 3 (fed sludge)	4,879	131	175	242	300
	4,880	111	156	199	225
	4,881	124	176	244	280
	4,882	163	220	277	280
	4,883	105	150	226	250
	4,884	107	149	196	220
Total weights		741	1,026	1,345	1,555

demonstrated in the intestines and liver. Several of these concretions were emulsified and injected into guinea pigs but the latter when killed six weeks later failed to show evidence of disease. The two calves were negative to the tuberculin test on March 16 and both were in good condition at the termination of the experiment.

GENERAL CONCLUSIONS

On the basis of the tests made, it is concluded that virulent bacteria are not present in sufficient concentration in the incoming sewage, effluent, and sludge of this sewage treatment plant to cause disease in susceptible animals. It is believed that the test animals in this experiment were subjected to a more severe exposure to effluent than would ordinarily occur in livestock below a modern-type sewage treatment plant.

Coal for Power Generation

Its Availability in the United States, Means of Production, and Cost

By C. Y. Thomas

Chief Engineer, Pittsburg and Midway Coal Mining Company, Pittsburg, Kans.

NATURE, states Mr. Thomas, has endowed this country with half the world's supply of coal, of which less than 1% has been used to date. Three-fourths of the electrical energy generated in our central stations is now from coal, one-fourth from falling water. In the best steam plants a pound of coal can be counted on to develop one kilowatthour of electricity. Where high-tension transmission from a hydroelectric plant would be required over a considerable distance, it has become cheaper, according to Mr. Thomas, to secure power from coal at a strategically situated steam plant. This paper has been prepared from his searching analysis of the relative merits of coal and falling water for power generation, originally presented before the session of the Power Division at the Society's Spring Meeting held in Kansas City.

DAILY, through the medium of newspapers, magazines, motion pictures, and the radio, we are impressed with the fact that those nations which have the greatest developed power, civil and military, rule the world. Mankind has improved his lot in direct ratio to his ability to create, harness, and utilize power. There can be no argument that misdirected use of power has all but brought modern civilization crashing down upon us, but while we are all fervently praying for a cessation of the holocaust now raging on two continents, many agencies are looking into the future and planning for "the more abundant life." The United States of America is able to look far ahead with no misgivings as to its future power supply. Whether or not technology presents us with a new and different source of power or power transmission, we have more potential power and energy than any other nation on the face of the globe.

Despite the efforts of learned men through the centuries, we are not as yet able to use directly any appreciable power from the greatest source of energy in our planetary system, the sun. Those secondary sources of energy—coal, petroleum, natural gas, water falls, wind mills, and certain products of the soil—are all ours in abundance. Most important of all, most generally available, best known, and most certain in the future is coal.

Table I. Distribution of Power in the United States
From Natural Resources Committee Report of June 1937 on "Technological Trends and National Policy"

Item No.	Power Source	Horsepower
1	Electric central stations	44,670,000
2	Industrial power plants	20,133,000
3	Electric railway plants	2,500,000
4	Isolated non-industrial plants	1,500,000
5	Mines and quarries	2,750,000
6	Agricultural prime movers	72,763,000
7	Automobiles, busses, trucks, and motorcycles	965,000,000
8	Airplanes	3,500,000
9	Locomotives	88,000,000
10	Marine	30,000,000
	Total	1,230,816,000

The vast increase in and the widespread use of power in this country is a study in itself, dating virtually from the beginning of the twentieth century, but we are vitally concerned with what we have today. Table I shows the sources of power in the United States as reported in June 1937 by the Natural Resources Committee.

As long as our petroleum discoveries keep up with present production, there seems little likelihood that products of coal or the distillation of agricultural products will displace appreciably Items 6, 7, 8, and 10 of this tabulation. However, in the central station generation of electric power, internal combustion engines are almost a negligible factor. Table II shows the growth in the installed capacities of central stations since 1902; that is, in Item 1 of Table I. It is from the same source as Table I.

Water power development has increased somewhat more rapidly than the installations of fuel-burning steam plants. While the larger and more spectacular hydroelectric developments are well known, it is interesting to note the comparison of fuel-electric and hydroelectric plants in the nation given in Fig. 1.

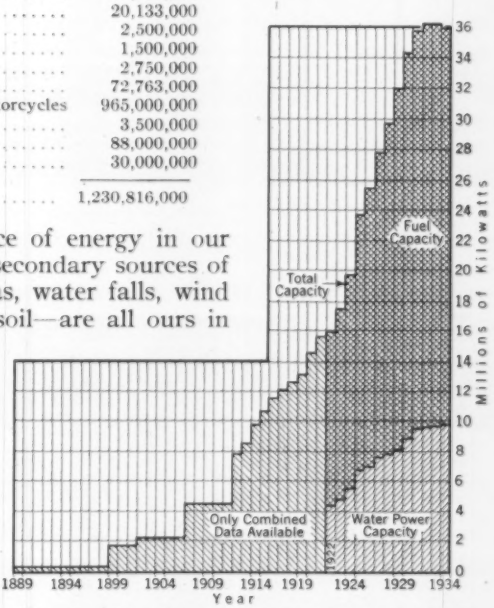


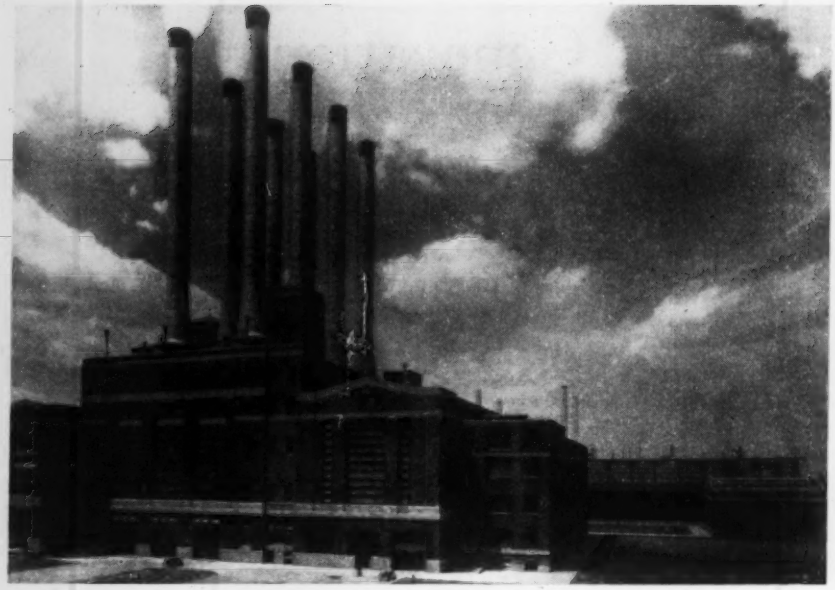
Fig. 1. Installed Capacity of Electric Generating Stations of Public Utilities in the United States
From Federal Power Commission Report

How Much Coal Is Available

Despite the tremendous increase in power consumption during the past half century there is every reason to believe that there will be just as great an increase in the future. The Natural Resources Committee Report of 1937 stated: "There seems to be no need for special concern about the resources available in this country to produce power by the present methods. Even with a greatly increased use of power, which is bound to come in the near future, our resources are adequate for centuries to come, if we continue to rely mainly upon coal burning plants."

Coal is the fuel of the future despite that most hazardous of prognostications—dealing with petroleum and natural gas reserves. It is true that new discoveries of the latter fuels have been keeping pace with exhaustion of older fields but no one will admit that the oil yet to be discovered will begin to approach in quantity the proven coal reserves.

Beginning with the discovery of coal along the Illinois River near the present town of Utica, Ill., in 1673, by the Jesuit missionaries Joliet and Marquette, coal has been found principally in 26 of our 48 states. Though it is generally believed that our major coal reserves are in the Appalachian region, Marius R. Campbell's monu-



DEARBORN (RIVER ROUGE) POWER PLANT OF FORD MOTOR COMPANY IS EXAMPLE OF MODERN DEVELOPMENT FOR A MAJOR INDUSTRY
World's Largest Industrial Power Plant

mental work (U.S.G.S. Professional Paper No. 100) shows the widespread location of coal beds; Fig. 2 shows the location of the major fields. Of the $3^1/_2$ trillion (3,535,690,990,000) tons of coal reserve in the United States, as of January 1, 1919, Campbell estimated that approximately

TABLE II. ELECTRIC GENERATING STATIONS—HORSEPOWER OF INSTALLED CAPACITY

YEAR	STEAM PLANTS	INTERNAL-COMBUSTION ENGINES	WATER POWER	TOTAL
1902	1,394,395	12,181	438,472	1,845,048
1912	4,949,778	111,035	2,469,231	7,530,044
1922	14,171,222	302,995	5,822,018	20,296,235
1930	31,000,000	600,000	11,600,000	43,200,000
1935	32,000,000	670,000	12,000,000	44,670,000

two-thirds is to be found west of the 100° W meridian, principally in Colorado and in the Rocky Mountain states; and the remainder east of the Missouri River. The states of greatest total production of coal from earliest record to the end of 1937 are Pennsylvania (10 billion tons), West Virginia (3 billion tons), Illinois ($2^1/_2$ billion tons), Ohio ($1^1/_3$ billion tons), and Kentucky ($1^1/_4$ billion tons). The total production from these reserves has been but 23 billion tons. It is evident that the western coal reserves have scarcely been touched and that less than 1% of all our vast coal reserves have been mined.

MINING METHODS BECOMING MECHANIZED

Coal is being mined today by two general methods—by underground methods through shafts or slopes, and by stripping. The shaft mines range from shallow pits producing a few tons a day to the amazing electrified and mechanized units producing as much as 10,000 tons in 7 hours. Mechanization with such equipment as cutters, mechanical loaders, and conveyors, is gradually raising the output per man-day. Most of the mechanized features have been developed for use in relatively thick coal seams ranging from 4 to 14 ft thick and more. As the less desirable reserves are worked, mechanization will undoubtedly be adapted to the thinner seams. Mechanized cleaning of coal is increasing rapidly although 1939 figures probably will show that but 14% of the coal mined is mechanically cleaned.

Although strip mining represents about 7% of the total, through Indiana, Illinois, Missouri, Kansas, and Oklahoma where conditions are favorable, are found many stripping operations. Coal is being uncovered with equipment ranging from slips and Fresnos to the gigantic electric shovels removing 35 to 40 cu yd of overburden with each dipperful. It is believed that the development of excavating shovels has about reached its peak.

The real value of the vast coal reserves scattered through 26 states cannot be fully realized unless it can be mined economically, transported at low cost, and finally utilized efficiently. The coal industry is directly responsible for the first cost and is indirectly affecting the other two items. Better preparation and cleaner coal mean more heat units transported at less cost. Cleaner and better coal usually results in less ash to handle, less sulfur to attack refractories and metals, and less atmospheric pollution, while uniform quality makes it possible to operate coal-burning plants at greater efficiency.

The selling price of coal, like that of virtually all commodities, is more or less responsive to the laws of supply and demand. Prices were quite stable except during the World War and the ensuing five years. There is no reason to believe that mechanization can bring prices to pre-war levels, because of considerably higher wages plus federal regulations, but there is every reason to believe that prices will not deviate greatly from existing levels.

TABLE III. COST OF POWER GENERATION COMPARED—STEAM PLANT AT MINE VS. HYDRO PLANT AT DAM—UNDER NORMAL RATES FOR CAPITAL AND TAXES

	STEAM PLANT AT MINE MOUTH	HYDRO PLANT AT DAM SITE			
		Cost $250 per Kw	Cost $200 per Kw	Cost $150 per Kw	Cost $100 per Kw
Total installed capacity (kw)	100,000	100,000	100,000	100,000	100,000
Cost per kw of installed capacity	$85	$250	$200	$150	$100
Total cost of plant	$8,500,000	$25,000,000	$20,000,000	$15,000,000	$10,000,000
Annual load factor (per cent)	50	50	50	50	50
Annual output (kwhr)	438,000,000	438,000,000	438,000,000	438,000,000	438,000,000
Annual fixed charges (per cent)	12.5	10.5	10.5	10.5	10.5
Annual fixed charges (dollars)	$1,063,000	$2,625,000	$2,100,000	$1,575,000	$1,050,000
Pounds of coal per kwhr*	1.18	....	....	....	....
Annual coal consumption (tons)	259,000	....	....	....	....
Annual cost of coal at $1.60 per ton	$414,000	....	....	....	....
Operating supervision, labor, and repairs†	$263,000	$131,000	$131,000	$131,000	$131,000
Total annual cost (dollars)	$1,740,000	$2,756,000	$2,231,000	$1,706,000	$1,181,000
Cost per kwhr (mils)	3.97	6.30	5.10	3.90	2.70
Recapitulation:					
(a) Fixed production costs: Mils per kwhr	2.43	6.00	4.80	3.60	2.40
(b) Variable production costs: Mils per kwhr	1.54	0.30	0.30	0.30	0.30
(c) Total production costs: Mils per kwhr	3.97	6.30	5.10	3.90	2.70

* Based on plant efficiency of 13,000 Btu per kilowatthour and heating value of 11,000 Btu per pound of coal.
† Estimated at 0.6 mil per kilowatthour for steam plant and 0.3 mil for hydro plant.

Any prediction as to future coal prices is precarious because we are momentarily expecting federal control of minimum selling prices. There have been numerous attempts to place the coal industry under federal regulation, although none to date has succeeded. The Bituminous Coal Act of 1937 provides for the Bituminous Coal Code and contemplates a minimum price structure. According to the best information available at this time, minimum prices will be made effective some time before August 15, 1940.

This is certainly not the place to pass judgment on the Bituminous Coal Act; in fact it is difficult to conceive or grasp the terrific job of setting minimum prices for 6,000 mines in 31 states and correlating them to please the miners, mine operators, and ultimate consumers. The intent of the law is to disregard geographical position and to correlate minimum prices so that the delivered prices of all coals at a given point will equalize values.

Because of the overproduction within the industry, of the competition with oil and gas, of importations of fuel oil, of hydro plants, it seems unbelievable that average coal prices will vary more than a very few per cent for many years to come. As a matter of fact, more widespread mechanization of coal mines plus some freight-rate readjustments may result in somewhat lower coal prices in the future, at least until it becomes necessary to start mining less desirable reserves. Even a 10% change in the delivered cost of coal to a modern power plant will amount to but 0.2 mil per kwhr in the cost of production of power, and almost never have fuel prices varied that much.

EFFECT OF TRANSPORTATION COSTS

Unlike power companies with their own high-tension lines, and pipe-line companies, neither coal producer nor consumer has much control over costs of transporting this solid form of energy. Practically no other commodity carried by the railroads has an average unit value less than the carrying charges. Thus, on another front, the coal industry is minutely regulated by the federal government, this time through the Interstate Commerce Commission.

For the year 1930 there are available figures contained in a special report issued by the Interstate Commerce Commission for the average freight revenue per car and average value per car of the different classes of commodities transported on Class 1 railways in the United States. By dividing average revenue per car by average value per car, it is possible to ascertain for each commodity group what relation freight revenue per car in that year bears to value of the commodity per car. Animals and products show the lowest percentages; manufacturing and miscellaneous come next at 4.2%; then agricultural products, 13%; then forest products, 23.3%. Mine products, with a percentage of 84, are entirely out of line with the other groups because they include bituminous coal, which has a percentage of 131.1.

DISPROPORTIONATE CHARGES

Using the 1930 figures for value per ton as being comparable to present-day values, it appears that the value of the 1935 tonnage in the six commodity groups, exluding bituminous coal, amounted to more than 38 billion dollars. The value of bituminous coal amounted to more than 38 billion dollars. The value of bituminous coal originating on Class 1 roads in 1935 was $436,471,000, or 1.14% of the total value of all groups of freight originated, yet coal, which represents a small portion of the value of other commodities, paid 22% of the freight revenues of the carriers. In this connection, the percentage of freight revenue to value of all other freight per ton is 6.1 as compared with 128.1 for bituminous coal.

As nearby mines are worked out and as industry moves or expands to places more distant from the mines, freight rates will become an even more important item in the ultimate cost of using coal.

TABLE IV. COST OF GENERATION AND TRANSMISSION OF HYDROELECTRIC POWER

Cost of Hydro Plant	Mils per Kilowatthour								
	At 200 Miles			At 100 Miles			At 50 Miles		
	Gen.	Trans.	Total	Gen.	Trans.	Total	Gen.	Trans.	Total
$250 per kw	6.30	2.29	8.59	6.30	1.80	8.10	6.30	1.52	7.82
$200 per kw	5.10	2.16	7.26	5.10	1.66	6.76	5.10	1.39	6.49
$150 per kw	3.90	2.03	5.93	3.90	1.53	5.43	3.90	1.26	5.16
$100 per kw	2.70	1.89	4.59	2.70	1.40	4.10	2.70	1.12	3.82

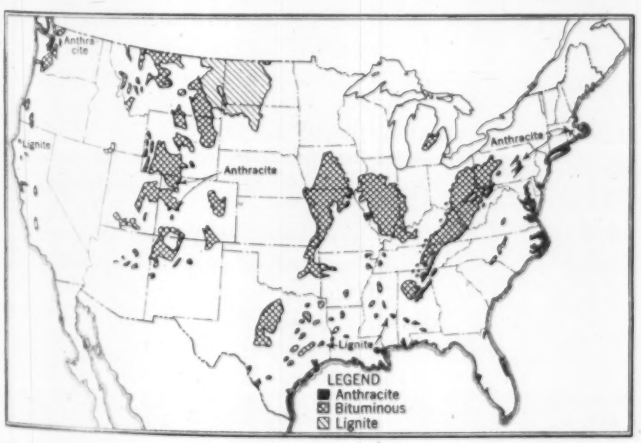


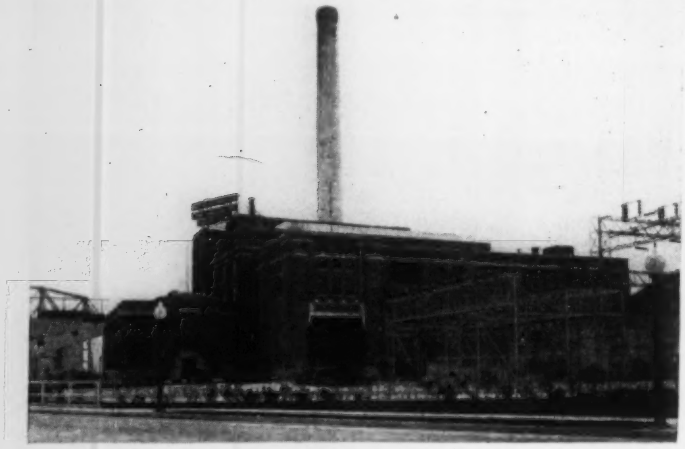
FIG. 2. MAJOR COAL FIELDS OF THE UNITED STATES
From U.S.G.S. Professional Paper No. 100 by M. R. Campbell

TRANSPORTING COAL VS. TRANSMISSION LINES

Despite the fact that bituminous-coal freight rates are considerably out of line with those of all other commodities, it is rarely realized that transporting energy in the form of coal in cars is much less expensive than conducting it over high-tension wires. The average user of power thinks only of the cost of generating the power, neglecting the cost of its transmission and distribution. While this is not a forum for discussing the relative merits of steam vs. hydro power, the spectacular development of hydroelectric plants at rather isolated places where long-distance transmission lines are necessary, has focused some attention on the problem of transmission. An examination of Tables III, IV, V, and VI, prepared by Frank F. Fowle, consulting engineer, seems to support the belief of many engineers that the ultimate in low-cost power coupled with a continuing prosperity, lies in hauling coal to strategically located steam plants.

It seems reasonable to conclude from Mr. Fowle's data that advocates of mine-mouth power plants are indulging for the most part in wishful thinking, and that almost regardless of subsidies, the enormous hydroelectric developments like Boulder, Fort Peck, Bonneville, Norris, and Wheeler can scarcely be depended upon for low-cost power in distant areas. Transmission of power a distance of 200 miles is not uncommon, yet nowhere is there a coal haul of 915 miles. It is almost impossible to find a location in this country more than 600 miles from an active coal-producing area. It is well recognized that a modern steam plant should be located where there is plenty of water, because it is cheaper to move coal than water.

There seems no reason to doubt that when there is a demand and a reasonable load and a location not served with power, steam plants can be strategically located. It is possible at the moment that at certain places fuel oil or natural gas may be cheaper than coal; certainly



WORLD'S MOST EFFICIENT POWER STATION—80,000-KW PLANT OF WISCONSIN ELECTRIC POWER COMPANY, PORT WASHINGTON, WIS.
Station Heat Rate for 1939 Was 10,770 Btu per Kwhr at 59% Load Factor

steam plants need never shut down for the lack of a dependable fuel standby.

The Natural Resources Committee in its June 1937 Report, "Technological Trends of National Policy," stated: "In many localities, however, absence of fuel cost does not make up for high fixed charges and low reliability of water power. The high efficiency and low fixed charges now possible in large fuel-burning plants, place hydroelectric developments at a disadvantage in most sections of the United States if low power cost is the objective. Water-power plants, due to their high fixed cost, depend even more than do fuel-burning plants upon a high use factor or load factor."

It being true that there is a seemingly inexhaustible supply of coal in our nation and that energy in this form can be transported in a railroad car at much less than transmission-line costs, it follows that steam generating plants must be efficient to complete the delivery of low-cost power.

Back in the 90's steam boiler pressures seldom reached 100 lb per sq in.; boilers were generally small and hand fired. It required 8 to 10 lb of coal to generate one kilowatthour of electricity. The turn of the century found steam pressures as high as 150 lb with a few modest installations of superheaters, and steam turbines were being introduced. When the Keokuk Dam was projected back in 1907, the average coal consumption of the utility power stations in this country was nearly $5^1/_2$ lb per kwhr. Today the average is 1.45 lb of coal per kwhr, with the better stations cutting this to less than 1.0 lb per kwhr. If the public utilities today used as much coal to generate one kilowatt as they did in 1907, they would be consuming not 40 million tons annually but 150 million tons.

The most modern steam power plants in the world today are in this country. A remarkable statement is taken from the last annual report of the Detroit Edison Company:

"Our steam power plants consumed 1,416,622 tons of bituminous coal bought in Kentucky, Virginia, and West Virginia, and the equivalent of 66,537 tons in blast-furnace and oil-refinery gas bought locally. The average price of coal was $3.78 per ton, substantially the same as in 1938. As heretofore, 39 per cent of the cost was the price of coal at the mines and 60 per cent the cost of freighting it to us by rail and lake. Improvement in power-plant efficiency made it possible in 1939 to generate each kilowatthour of net output with 0.96 lb of coal. This required an even pound in 1938, and 1.27 lb in 1929."

A simple calculation shows that the coal cost was 1.8 mils per kwhr.

The review in the January 1940 issue of *Combustion* of 90 new central-station units put in operation or being erected in 1939 reveals almost unbelievable figures:

1 plant will operate at steam pressure of 2,650 lb per sq in.
33 plants will operate at steam pressure of 1,400–1,500 lb per sq in.
26 plants will operate at steam pressure of 800–1,000 lb per sq in.
30 plants will operate at steam pressure of 700–800 lb per sq in.

Sixty-three of these units will use pulverized coal as fuel, 8 will be stoker-fired coal plants, and 19 will use oil or gas as fuel. Two-thirds of these units will employ steam temperatures of 900 F or above.

TABLE VI. COMPARISON OF TRANSMISSION COSTS OF ELECTRICITY VS. COAL

50 miles on 66-kv twin circuits equals cost of 540-mile coal haul via rail
100 miles on 132-kv twin circuits equals cost of 670-mile coal haul via rail
200 miles on 220-kv twin circuits equals cost of 915-mile coal haul via rail

The world's most efficient power station, the Port Washington Station of the Wisconsin Electric Power Company, has completed its fourth year of operation. The record, again from the January 1940 issue of *Combustion*, is:

YEAR	BTU PER KWHR	YEAR	BTU PER KWHR
1936	10,954	1938	10,788
1937	10,835	1939	10,770

Boiler availability has been 93.4% and turbine availability 93%.

The Dearborn plant of the Ford Motor Company is the world's largest industrial power plant. There a single boiler will produce a million pounds of steam per hour, operating at 1,350-lb pressure and at a steam temperature of 910 F. The coal cost per kilowatthour at this plant is about $1^2/_3$ mils.

These remarkable fuel records in modern power plants of both utilities and industry seem to show conclusively that coal can and probably will be the source of low-cost power for many generations in the future. The actual cost of power generation is approximately one-third of its average selling price, indicating that the greatest opportunity for reducing power costs lies in the field of transmission and distribution.

TABLE V. COAL HAUL WHICH MAKES COST OF STEAM POWER EQUAL TO HYDROELECTRIC POWER

Power Cost in Mils per Kilowatthour, Coal Haul in Miles

COST OF HYDRO PLANT	TRANSMISSION 200 MILES			TRANSMISSION 100 MILES			TRANSMISSION 50 MILES		
	Cost of Hydro Power	Excess Cost Over Steam	Coal Haul for Equal Cost	Cost of Hydro Power	Excess Cost Over Steam	Coal Haul for Equal Cost	Cost of Hydro Power	Excess Cost Over Steam	Coal Haul for Equal Cost
$250 per kw...	8.59	4.62	1,980	8.10	4.13	1,740	7.82	3.85	1,610
$200 per kw...	7.26	3.29	1,340	6.76	2.79	1,090	6.49	2.52	965
$150 per kw...	5.93	1.96	690	5.43	1.46	450	5.16	1.19	320
$100 per kw...	4.59	0.62	43	4.10	0.13	*	3.82	0.15	*

* Hydro is more economical than steam.

Gasoline Pipe Lines—Design and Construction

The "Baby of the Pipe-Line Family" Makes Rapid Progress

By A. H. Riney, M. Am. Soc. C.E.
and Stanley Learned

Respectively Vice-President in Charge of Engineering, and Chief Engineer, Phillips Petroleum Company, Bartlesville, Okla.

KEEN competition in the oil industry is the driving force behind the continuous quest for more economical modes of transportation. Newest development in this quest is the gasoline pipe line, of which some 6,800 miles are now in use. The reasons for its rapid growth, the hydraulics of design and the methods of construction, are all outlined in this paper, which was on the Construction Division program at the Society's 1940 Spring Meeting.

IN supplying petroleum products for the engines of the world, the oil industry has developed widely diversified and geographically spread operations, such as prospecting, drilling, producing, refining, and marketing. By necessity these operations are carried on in different sections of the country. For example, the greater portion of the oil is produced in the mid-continent and Texas areas, whereas the markets are largest in the more densely populated sections of the north central and northeastern states. Thus like any other industry engaged in widespread and large-scale production and marketing of low-priced commodities, the oil industry depends in a large measure on low-cost, efficient transportation.

This problem has been attacked from two general approaches. One has been to move the crude oil to refineries located in the larger marketing areas, refine the oil there and distribute the finished products within the vicinity of the refinery. The other approach has been to place the refineries in the producing areas, refine the crude oil, and then transport the finished products to the larger marketing areas for local distribution.

The first approach involves long-distance transportation of crude oil; the second involves long-distance transportation of finished petroleum products. The same general methods of transportation are employed for each—trucks, tank cars, ocean-going tankers, river and lake barges, and pipe lines. Despite all these special means of transportation, the oil industry is still the largest single railroad shipper of manufactured products in the United States.

Figure 1 shows the directional flow of the pipe lines in the United States. The continuous lines are for crude oil, and the map shows that most of them run either to the Gulf coast, or northeasterly to the north central and northeastern states. On the Gulf coast the oil is either refined and the finished products moved out in tankers, or the crude itself is transported in tankers to the eastern seaboard. In the north central and northeastern states, refineries along the crude lines convert the crude into finished products for consumption in the immediate areas around the refineries. The broken lines on the map show some of the larger gasoline pipe lines which move finished petroleum products from refineries in the producing areas to such points as Minneapolis, St. Louis, Chicago and New York.

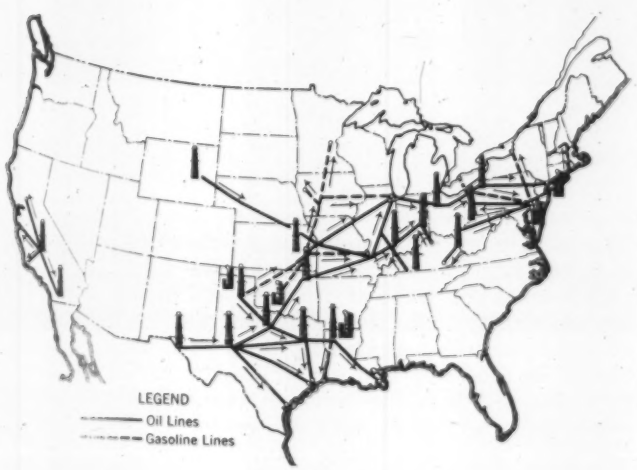


Fig. 1. Directional Flow Map of Crude-Oil and Gasoline Pipe Lines

Figure 2 shows the gasoline pipe lines on a map that also shows the relationship between gasoline production and gasoline consumption by states. It will be noted that Texas, Oklahoma, and Kansas produce much more than they consume, while some of the northern states consume but do not produce. Consequently the pipe lines shown on the map were built to move the gasoline from the producing areas to the larger consuming areas.

Gasoline pipe lines would be better termed "finished-product" pipe lines, because many of them carry not only motor fuel but natural gasoline, butane, burning oils, fuel oils, kerosene, and distillate. The various materials are pumped in "slugs," one behind another, and are delivered free of contamination because the lines are operated at rates which assure turbulent flow.

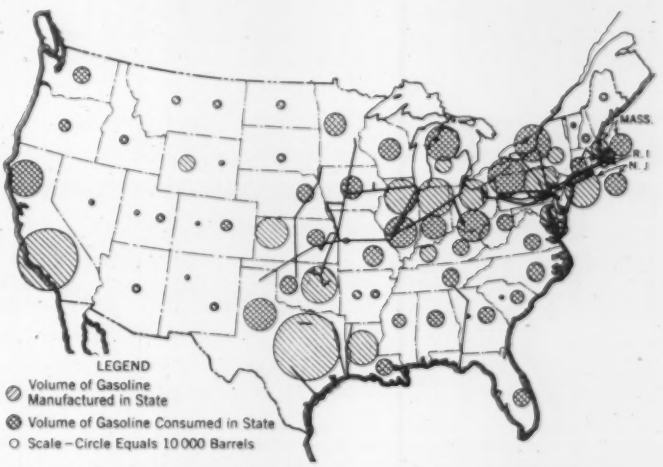


Fig. 2. Principal Gasoline Pipe Lines, and Relation Between Gasoline Production and Gasoline Consumption by States

Gasoline lines are the baby of the pipe-line family. Other members of the group are the crude oil lines, al-

ready referred to, and the natural gas lines. The comparative mileages of the systems are as follows:

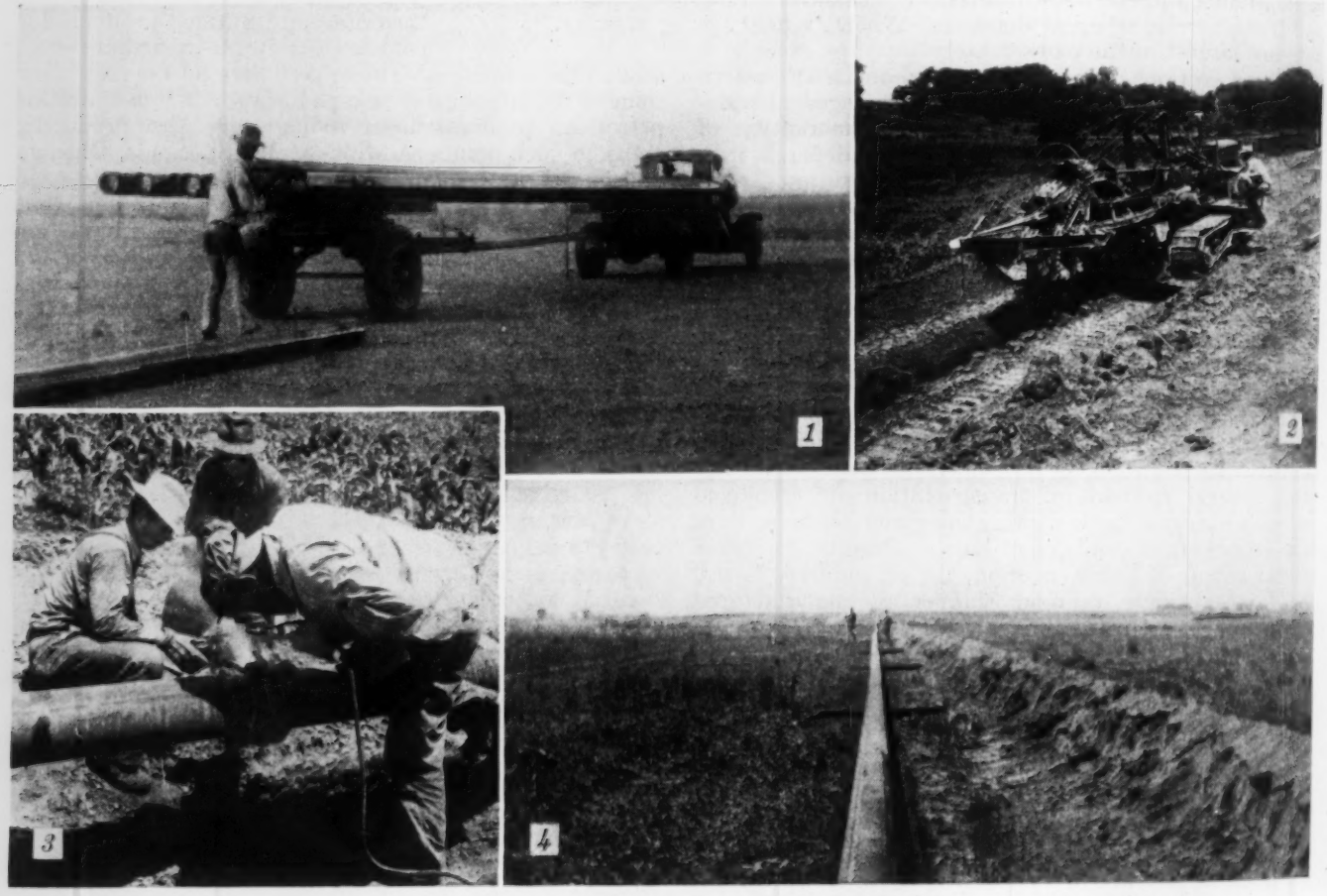
TYPE OF LINE	TRUNK LINES	DISTRIBUTION AND GATHERING	TOTALS
Natural gas	82,000 miles	101,000 miles	183,000 miles
Crude oil	75,000 miles	53,000 miles	128,000 miles
Gasoline	6,800 miles	.....	6,800 miles
			317,800 miles

The first long-distance gasoline pipe line was built in California in 1926. It was a 4-in. line about 100 miles in length. Since that time the growth has been rapid. There are several reasons for this expansion:

1. The average percentage yield of gasoline from crude oil has increased from 11% in 1910 to 45% in 1938. When gasoline was only a comparatively small part of the products of crude oil, it was not economical to build a separate line to handle it. Now that it has become a large part of the yield—and inasmuch as butane, kerosene, fuel oils, and distillates can also be slugged through gasoline pipe lines—the construction of such lines offers a means of economical transportation.

2. Gasoline pipe lines enable oil companies to locate refineries in the producing areas and still compete with refineries located in the large marketing areas. Refineries in the fields where the oil is produced are advantageous because they are in a better position to take advantage of processes involving the interchange of products between the refinery and gasoline plants. As an example, one of the country's largest inland refineries located at Borger, Tex., is in an area which has a large number of gasoline plants. This refinery is now taking advantage of new processes which utilize waste gases from gasoline plants. It is able to produce a higher quality gasoline and at the same time realize a materially greater yield of gasoline from crude oil than the 45% average for the industry.

3. Gasoline pipe lines help to stabilize employment. With such lines available to carry refined products away to storage at strategically placed terminals, the refinery is able to operate at a constant rate the year



DITCHING, WELDING, AND LAYING

(1) Pipe for the line comes in approximately 47-ft lengths, and is distributed by truck along the route. The pipe sealers visible in the end of each joint are installed at the factory to assure a clean line, and are removed just prior to welding. (2) The ditching machine moves steadily cross-country, on occasion making as much as 1,000 ft an hour. Here it is cutting a ditch for an 8-in. line with 24-in. minimum cover. Meanwhile (3) the pipe lengths are lined up and tack-welded. Alinement must be accurate to insure perfect welds and to provide a uniform interior surface that will minimize friction losses and allow the running of scrapers to clean the line when required. Final welding of the pipe into five-joint lengths is usually completed before the line is placed over the ditch. This allows the welder to do all his work at the top of the pipe, and makes for better workmanship. The five-joint lengths are then placed over the ditch and welded together (4). To assure that the all-welded line will not pull apart in cold weather, it is dropped into the ditch in compression. All but every third or fourth skid shown in (4) are removed, allowing the pipe to hang like so much rubber hose. Then in early morning, when the temperature is low, the rest of the skids are removed and the excess pipe resulting from the snaking over the skids is forced into the ditch.

round, though the seasonal demand for gasoline fluctuates markedly. The storage at the terminals takes care of the fluctuating demand.

A careful analysis of probable immediate and future loads on a gasoline pipe line is necessary for the most economic design of a proposed system. After probable line load and maximum operating pressures have been determined, designs for various size lines and station spacings are made, using the Hazen and Williams hydraulic formula. From a comparison of investment and operating costs for the various design schemes, the best is selected.

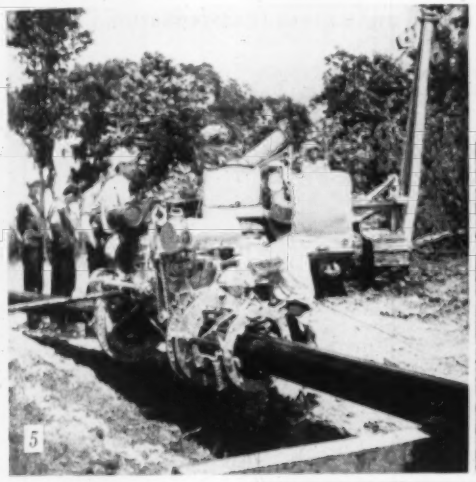
In general, the construction of gas, oil, and gasoline lines is similar. However, the design of each type of line involves different hydraulic formulas. The gas flow equation has to take into account the compressibility of gases. Formulas for the flow of oil and gasoline do not have to consider compressibility, but they do have to take fluid friction into account.

The flow of gases is generally calculated from Weymouth's formula, which is based on the assumption that gas behaves according to Boyle's and Charles' law. The formula is:

$$Q = \frac{853.5\, D^{2.667}\, (P_1^2 - P_2^2)^{\frac{1}{2}}}{L^{\frac{1}{2}}}$$

where Q = cu ft per day of 0.65 specific gravity gas at base pressure of 14.65 lb per sq in. absolute, base temperature of 60 F, and flowing temperature of 40 F
D = actual internal diameter of pipe in inches
P_1 = upstream pressure in lb per sq in. absolute
P_2 = downstream pressure in lb per sq in. absolute
and L = length of line in miles between points of pressure determination

The formulas for the flow of oil and of gasoline, while not identical, are similar in form, the main difference being in the method of considering the fluid friction. Oil flow is calculated from the D'Arcy formula, which takes into account the difference in viscosities of various crudes. The Hazen and Williams formula for the flow of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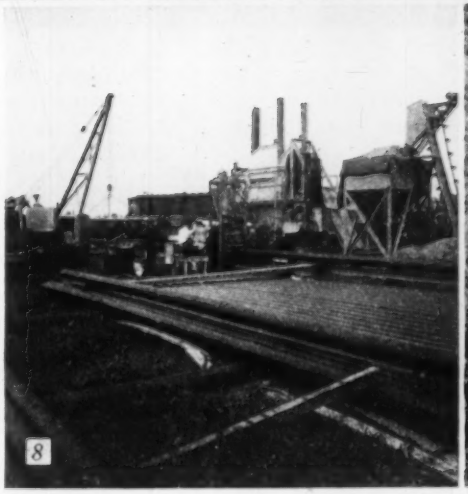
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CORROSION PROTECTION

Prior to laying the line, a corrosion survey is made (comprising soil resistivity readings and a general study of drainage and soil conditions and the experience of others in similar areas). On the basis of this survey, the location of portions to be coated for corrosion protection is determined. In such portions the pipe is first machine-cleaned and primed (5), then coated with coal tar or asphalt enamel (6). (In (6), the "sling" method of applying the coating is being used; where the section to be coated is long, machine application is preferred.) The final step in protection, also accomplished by machine, is wrapping with paper to protect the coating from abrasion. For extremely corrosive areas such treatment is not sufficient. In some cases very thick coal-tar coatings covered with concrete are used; in others a $\frac{1}{2}$-in. "Somastic" coating (7) is applied. The latter is essentially a densely graded asphaltic concrete with 1% by weight of long-fiber asbestos. The pipe may be coated by a traveling plant, but on new lines it is more economical to set up a central plant (8), and merely finish the joints along the line. Final step in construction of the line proper is the backfilling of the ditch (9). The line is then tested to hydrostatic pressures somewhat greater than the proposed operating pressures. By adding enough caustic soda to the test water to bring its pH up to about 10, inside corrosion is eliminated.

gasoline assumes that the viscosity of all gasoline is about the same as that of water. The two compare as follows:

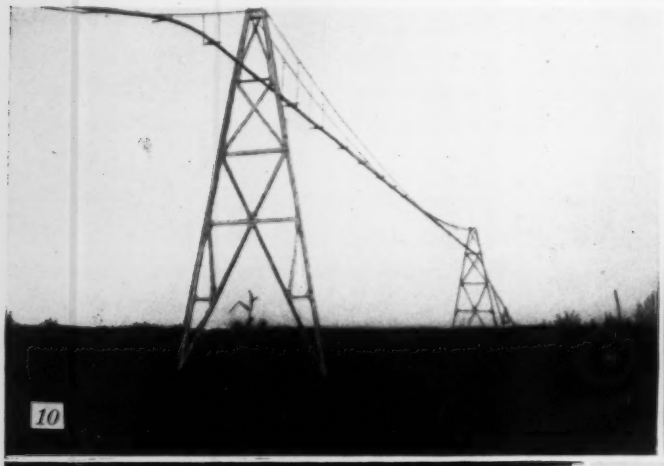
OIL—D'ARCY	GASOLINE—HAZEN AND WILLIAMS
$Q = \frac{P^{0.5} \times D^{2.5}}{6.61 \times F^{0.5} \times S^{0.5}}$	$Q = \frac{P^{0.54} \times D^{2.63} \times C}{162.04 \times S^{0.54}}$
Q = discharge in bbl per hr	Q = discharge in bbl per hr
P = lb per sq in. friction loss per mile	P = lb per sq in. friction loss per 1,000 ft
D = inside diameter of pipe in in.	D = inside diameter of pipe in in.
S = specific gravity	S = specific gravity
F = friction factor which takes viscosity into consideration	C = friction factor which is based on a constant viscosity of the liquid

Because of the fractional exponents and the number of variables in all these formulas, the use of nomographs or alinement charts for solution of the formulas is a great time saver. The accuracy of solution by this method exceeds the accuracy of the data used.

The first item in construction is the selection of a route. The most economical route for a line is as near as possible a straight line between any two points to be served, the line deflecting only to miss towns and other major developments. After a preliminary route has been selected by use of the best available maps, and checked by auto or aerial reconnaissance, aerial photographs are made. From these photos the final route is selected and the right of way purchased.

Actual construction procedures are illustrated in the accompanying photographs, taken in 1939 during the building of the line from East St. Louis to East Chicago. The pictures are arranged in logical sequence in three groups—"Ditching, Welding, and Laying," "Corrosion Protection," and "Miscellaneous Structures and Terminals"—with running comments on pertinent points. The work pictured is a project of the Illana Company, a subsidiary of the Phillips Petroleum Company.

The vast system of pipe lines in existence today—gas, oil, and gasoline—has been one of the oil industry's answers to the transportation problem. As new conditions present themselves in the future, improvements will be made, and possibly entirely new methods will be developed. Keen competition has been and will continue to be the driving force behind the development of new and more economical methods of transportation.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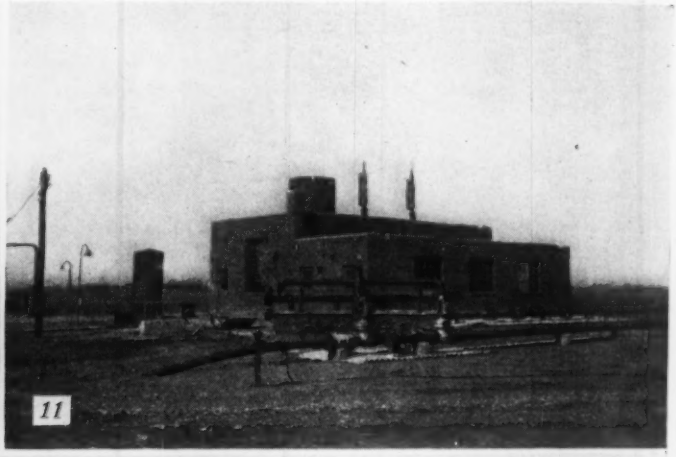
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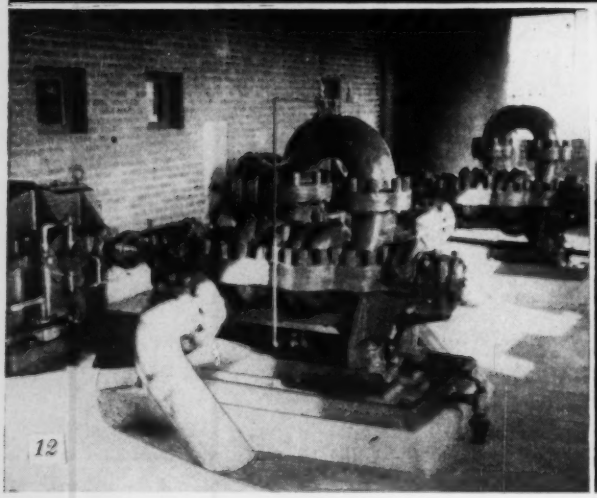
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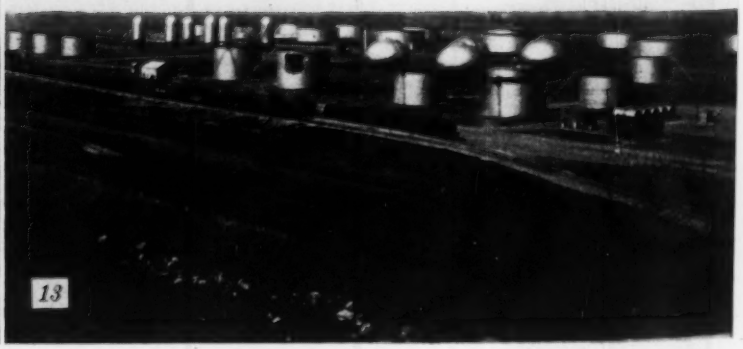
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MISCELLANEOUS STRUCTURES AND TERMINALS

Suspension bridges are sometimes used to carry the line over rivers or drainage canals. The bridge in (10) is 300 ft between towers, and the towers are 73 ft high. Every pump station (11) consists of a prime mover and a pump. Frequently the prime mover is a gas engine driven with butane, supplied through the line itself. Centrifugal pumps (12) are generally used as they are ideally adapted to systems closed from the point of input to the final destination. Efficiencies as high as 82% are attained in the designs. The typical pipe-line terminal (13) consists of tankage to handle various types of petroleum products. Tanks with floating roofs are used for normal gasoline, spheroids for natural gasoline, and blimps for butane. Railroad facilities are provided, and many pipe-line terminals are also served by trucks and water transportation.

TOWARD THE END OF THE REVAMPING PROCESS
Six of Seven Spans Raised

Raising and Widening Concrete Bridge in Chickamauga Reservoir

By EVERETT SCROGGIE
ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ASSOCIATE STRUCTURAL ENGINEER, TENNESSEE VALLEY AUTHORITY

LESS spectacular perhaps than the monumental jobs, but equally important in the aggregate, are the smaller engineering projects. Such was the reconditioning of the Wolftever Creek concrete bridge occasioned by the flooding of Chickamauga Reservoir. Studies convinced the TVA engineers that it was cheaper to raise the seven-span structure than to rebuild it. Incidentally this also provided opportunity for the state engineers to widen it. Mr. Scroggie here describes how it was successfully jacked up about 14 ft, split longitudinally along the center, spread apart 4 ft, and additional concrete and steel added.

BRIDGES are frequently raised or moved to a new permanent position, or they may be widened for traffic. But the Wolftever Creek Bridge in its recent reconstruction was both raised and widened in a single continuous operation.

One of the main state highways from Chattanooga to Knoxville traverses the Tennessee Valley on the east side of the river. In several places it had to be raised or relocated by the Tennessee Valley Authority when Chickamauga Dam was completed and its reservoir filled. One of these points was Wolftever Creek, approximately 15 miles north of Chattanooga and 10 miles above the dam. The existing bridge and road were at El. 680.7 or 4.3 ft below the surcharged reservoir elevation. Obviously it was necessary to relocate them on higher ground or raise the bridge and approaches on the existing location. After extensive study, the latter procedure was adopted.

The minimum finished grade on the bridge was determined by the navigation clearances for small boats. This was provided in the second span from the north and consisted of 40-ft horizontal clearance and 9-ft vertical clearance at normal pool elevation 682.0. Thus the grade of the existing bridge had to be raised an average of about 13.5 ft. The gradient of the finished floor was changed from level to a +0.4% from south to north in order to obtain the best profile on the approaches.

VIEW ALONG CENTER LINE OF RAISED SPANS
Foreground, Floor Slab Cut Through; Middle, Both Half Spans Spread Laterally by Track Jack; Distance, New Center Strip Being Concreted

As shown in the illustrations, the existing bridge consisted of seven 43-ft concrete T-beam spans (four T-beams per span) with a clear roadway width of 20 ft between curbs. The railing was of concrete with precast balusters, but the wearing surface was integral with the floor slab.

The substructure included concrete piers of the dumbbell type adjacent to the stream channel, two-post concrete frame bents on the banks, and concrete spill-through abutments. All foundations were on rock. This bridge, constructed in 1930 for H-15 live load, was in excellent condition.

With the construction of Chickamauga Dam the importance of this highway is increased considerably as it will provide access to two parks adjacent to the reservoir and an alternative short route to Knoxville. Hence, the State Highway Department wished to widen the bridge to a minimum of 24 ft between curbs, and was willing to bear the cost, if reasonable.

Various schemes were designed and estimated. They definitely demonstrated that it would be more eco-

nomical to raise the existing superstructure and extend the substructure than to demolish all, or part, of the bridge and replace it with new construction. Accordingly, this scheme was adopted for the final design.

Conventional methods of widening the roadway on a bridge of this type were found to be uneconomical, or unsatisfactory. The method of removing each curb and railing and widening on each side of the roadway was found to be too expensive. Widening on one side was also expensive and gave an unsymmetrical crown. The method adopted was to cut the bridge longitudinally along the center line, spread the two halves, and fill in between with new floor construction (Fig. 1). To our best knowledge this scheme has never been used before in widening a bridge. It was particularly advantageous in this case because the spans had to be raised anyway and it did not require any extra equipment other than small rollers for moving the parts laterally. The new roadway slab, approximately 4 ft wide, was supported on steel I-beams encased in concrete, to conform to the existing T-beams in appearance. The encasement was integral with the new slab and supported the old slab also. The forms for the slab and beam encasement were suspended from the beams themselves.

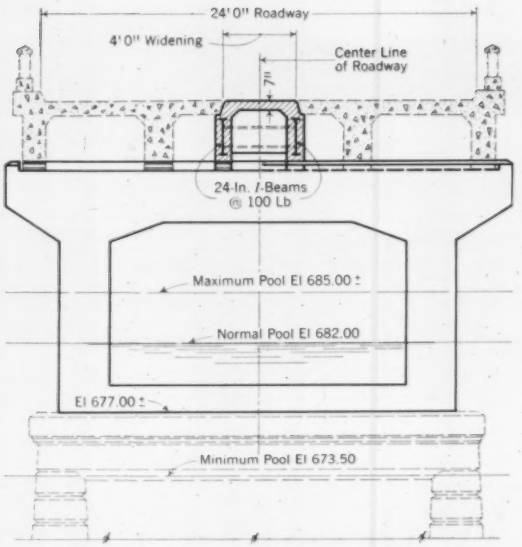


FIG. 1. VERTICAL SECTION SHOWING OLD AND NEW WORK

In addition to effecting a saving by eliminating falsework this procedure avoided unequal dead-load deflections of the old and new slabs which would have resulted if falsework had been used. In this connection it is of interest that after a period of service of six months no cracks or openings can be found. Lateral displacement of the superstructure is prevented by keyways at the fixed ends of the spans and shear lugs on the steel rollers used at the expansion ends.

The location of the expansion joints for the superstructure spans was determined by the existing framed bents. These were found to be inadequate to carry all longitudinal forces after the bridge was raised; therefore all bearings for spans supported on framed bents were fixed on the bent extensions to carry longitudinal forces—except those from temperature changes—back to the new abutments for transfer to the foundations. The three piers were found to be capable of carrying all forces that would act on them, and expansion joints were placed over each. This arrangement eliminated three of the existing expansion joints in the deck slab. The existing expansion bearings consisted of steel sliding plates. These sliding plates were replaced with $5\frac{1}{2}$-in. diameter roller bearings to reduce friction forces at the new expansion joints. Fixed ends of the spans were keyed into the new caps.

Extensions for the piers and bents were constructed as reinforced concrete frames with caps cantilevered to accommodate the extra roadway width (Fig. 1). No attempt was made to match the appearance of the existing substructure as it would be entirely submerged at normal reservoir level. The extensions were anchored to the existing concrete caps by means of dowels grouted into drilled holes and by keyways cut at suitable intervals. Simplicity was the keynote and all surfaces and lines were kept plain. The only variations made were in the heights of the extensions and the use of riser blocks on the pier extensions to conceal the steel rollers.

Extending the existing spill-through abutments presented a more difficult problem. After considerable study it was decided to use a box-type abutment with a T-beam floor, and solid panel railing. The roadway was flared to provide a transition from the wider roadway on the earth approaches. This gave a better appearance to the structure and eliminated several difficulties encountered in trying to extend the existing spill-through abutment, which now serves as a support for the breast-wall of the new abutment. The other end of the abutment is supported on untreated timber piles.

It was decided to detour traffic while altering the existing bridge. An old county road and bridge, located about 200 ft downstream, had to be repaired before traffic could use them.

When bids were first received, on September 19, 1938, the total cost for the project exceeded the estimated cost, and it was decided to re-advertise. However, from com-

FINISHED STRUCTURE BEFORE RESERVOIR WAS FILLED
Water Now Covers All of Old Structure

ments made by contractors it was concluded that detail plans showing a working scheme for raising and widening the superstructure would be very valuable information to include with the details of the alterations; also, several requests were made for the opportunity of bidding on demolishing the existing superstructure and constructing a new one. Following this procedure bids received on January 23, 1939, were several thousand dollars lower than those previously received. It is interesting to note that two bidders submitted lower figures the second time. The reduction may be credited to the use of information drawings, since the major portion of the contractors submitting bids were primarily interested in grading work and were not accustomed to such unusual bridge work. The low bidder, A. T. Anz, of Petersburg, Tenn., was awarded the contract.

Modification was cheaper than rebuilding in all bids. Contract prices for bridge items were as follows:

Earth excavation	$ 1.00 per cu yd
Class A concrete	26.00 per cu yd
Class S concrete (railings)	45.00 per cu yd
Reinforcing steel	0.05 per lb
Structural steel	0.10 per lb
Untreated timber piling	1.40 per lin ft
Raising existing bridge	1,000.00 per span
Cutting and separating existing superstructure	500.00 per span

These unit prices were reasonable and the final cost of the structure, about $35,000, was less than the estimated cost. Work began on the bridge proper in April 1939 and was completed in September 1939. Construction was not rushed, as the grading work took more time to complete than the bridge.

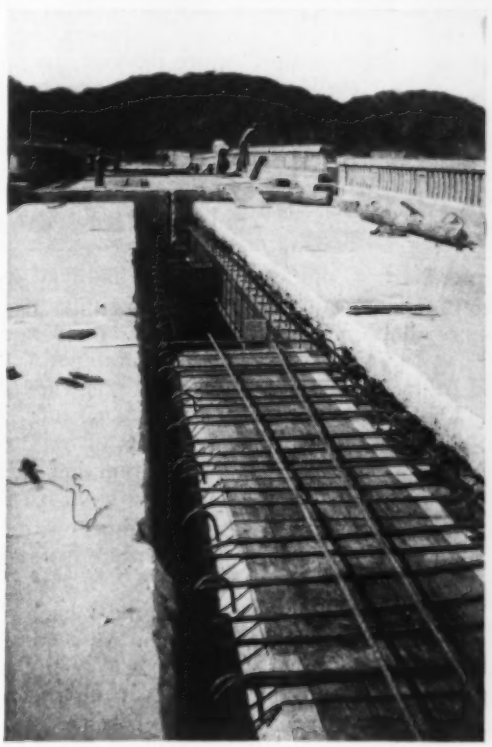
Four 40-ton hydraulic jacks were used to raise each span. Framed tower bents of timber, approximately 8 ft square (see illustrations) and resting on mud sills, were placed at each jack location. The jack was supported on a trussed beam, $7\frac{1}{2}$ in. deep at the bearings, with its head engaging a special timber jacking beam for lifting the span. Eight-inch lifts were made, and 8 by 8-in. cribbing pieces were used to take up each lift. The jack and its steel beam support were raised after each lift and turned through 90° to rest on the new layer of cribbing. For this operation the $7\frac{1}{2}$-in. depth of the trussed beam at its bearings provided clearance between the 8-in. cribbing for rotation between lifts. A trolley beam, attached to the slab by bolts in holes subsequently used to split the spans longitudinally, was used to lift the cribbing pieces from the ground to the working level. The spans were raised at the rate of 1 ft per hour, approximately, and were carried about one foot above their final position for working clearances. The order of raising the seven spans was left entirely to the contractor, based on his requirements for the grading work.

Some railing posts over the piers and bents had to be removed for clearance and were reconstructed after the spans were seated in final position. The extension for each pier and bent was constructed as soon as the spans it supported were jacked out of the way. This applied to the abutments also. The spans were not allowed to bear on the new parts of the substructure until the concrete had reached a strength of 2,500 lb per sq in., as indicated by tests cylinders. Extra cement was used in some parts to obtain high early strength to permit re-use of cribbing. This was done by the contractor at his own expense.

NEW WORK PARTIALLY COMPLETED—END BENT EXTENDED TO FORM NEW ABUTMENT AND TWO ADJACENT SPANS RAISED

The spans were cut in two along the center line of the roadway by drilling holes 6 in. on centers, with pneumatic drills, and breaking out the remaining concrete. Reinforcing steel was flame cut. The amount of spalling of the bottom of the slab was not serious. A 4-in. fillet was added to the encasement for the new beams and covered practically all spalled areas.

For separating the halves 4 ft laterally, each was first lowered to a series of 3-in. rollers, supported on the new concrete caps, or timber blocking at the expansion ends of the spans. Steel plates were used to reduce friction. A track jack was placed in the space between the girder stems or in the slot in the slab to move the halves laterally. The half spans were then lifted from these temporary rollers, by means of the hydraulic jacks supported on the new concrete caps, and lowered to the final bearings of steel rollers or grout.



NEW FLOOR FORM AND STEEL FOR 4-FT WIDENING

Reference points, established on the spans before operations began, were used to place them in their new positions. The final alinement and grade on the finished structure are as nearly perfect as one could expect. With the old substructure submerged at normal reservoir level, it is difficult to tell that the structure has been altered so much. The earth approaches have not been paved to date, and traffic soon discolored the new strip of concrete roadway slab to match the existing slab.

Responsibility for this work on the part of TVA was shared by T. B. Parker, chief engineer; H. A. Hageman, chief design engineer; F. W. Webster, head highway engineer; and Erwin Harsch, senior structural engineer—all members of the Society. S. F. Vesser, later succeeded by A. E. Rush, was associate highway engineer in charge of construction. The writer supervised the design, preparation of detail drawings, and preparation of specifications.

Pollution Abatement in New York Area—the City Itself

By R. H. Gould, M. Am. Soc. C.E.

Acting Deputy Commissioner, Department of Public Works, City of New York, N.Y.

THIS is the fourth and concluding article of a series on pollution abatement in the New York area. The first, which appeared in the May issue, dealt with interstate problems; the second, with progress in the municipalities west of the Hudson; and the third, with developments in Westchester County and Long Island. Here Mr. Gould takes up the problems of New York City itself. Pointing out that $148,000,000 will be required to complete the necessary treatment works, he stresses the importance of "a definite and assured income" for this purpose "from sources other than real estate and taxes," and suggests placing the program on a self-sustaining status based on services rendered. His paper is from the Sanitary Engineering Division program at the 1940 Annual Meeting.

ANY solution of the sewage treatment problem in the New York metropolitan area will be very largely influenced by what happens to the sewage originating in New York City. Mr. Hess, in the May issue, has outlined the progressive increase in pollution with the growth of the metropolitan area and has told of the major steps that have been taken to correct this evil. Establishment of the Interstate Sanitation Commission has been one of the milestones on the long and uphill road toward the objective for which we are all striving so earnestly. The very fact of its establishment is concrete evidence of a popular desire for the elimination of sewage pollution from the waters of the New York metropolitan area.

New York City is in entire sympathy with the objectives that led to the establishment of the Commission and has given wholehearted support to its operations. This has been with full realization on the part of the city that it would have to solve its own problem for the most part and that, because of the limited jurisdiction of the Commission, limited help could be expected from that source. Of the entire population of the metropolitan district, that of New York City makes up about 70% of the total. The Passaic Valley Sewerage District, which is not under the jurisdiction of the Commission, accounts for 10%, while the remaining 20% lies in other communities in the states of New York and New Jersey. The location at which pollution enters the waters of the district makes a great difference in its effect on New York City objectives. It is probably true that of the New York State and New Jersey population just mentioned, only about two-thirds will have an important bearing on the New York City problem. In other words, we can expect help with only about 14% of the problem.

Aside from maintaining certain standards of decency in the quality of the waters of the inner harbor, one of the main objectives of the city's program is to restore and make safe for bathing the waters available for recreational use. In general, these are the waters that have been placed in the Class A designation by the Interstate Sanitation Commission. It should be clearly understood that under the present definitions and requirements of the Commission, these Class A waters will not necessarily be safe for bathing or the taking of shellfish. The criterion in force is the degree of purification of sewage discharged into Class A areas, but not the actual condition of the waters themselves as they flow across an imaginary line into those areas. The New York City program is planned to fit in with the physical conditions as they actually exist, so that Class A waters that can be controlled by the city alone will be in fact safe waters.

Some of the results of our summer harbor survey work for 1939 are shown on Fig. 1. The upper diagram is a series of profiles through the main water courses, showing the average values of dissolved oxygen in terms of percentage of saturation. The minimum values in all cases were substantially lower. The lower diagram gives corresponding values for the number of B. coli per cubic centimeter (or Escheri coli, if you happen to be of the modern school). These diagrams show strikingly the effect of distance and time of flow from major sources of pollution on the natural purification that takes place in the harbor waters, and emphasize the fact that if we are looking for definite conditions in waters used for recreation, we must sometimes go to the source of the pollution for adequate protective measures.

Additional data on dissolved oxygen were presented by Mr. Hess in the May issue, from last year's work of his Commission. On his Fig. 3 were plotted the results secured at the Narrows, arranged in accordance with times before and after low water. It is of interest to note from that figure that the general average of the dissolved oxygen content on the ebb tide is in the neighborhood of 55% of saturation, while that on the flood tide is only about 35%. From these data it would appear that the tidal currents take away more dissolved oxygen from the inner harbor on the ebb than they add to it on the flood tide. In the past there have been a number of determinations made over tidal cycles at this point. Generally, the flood current carries somewhat more oxygen than the ebb current, although there are records of the reverse condition, similar to that found by Mr. Hess, although not in the same magnitude.

It is not surprising that Mr. Hess has not been able to detect an improvement in the dissolved oxygen conditions at the Narrows this past year due to the operation of the Wards Island Sewage Treatment Works. In the first place the seasonal, daily, and even hourly fluctuations of dissolved oxygen at any one point are such that the chance in sampling at any particular time makes appreciable errors possible in striking averages. Then, too there is a possibility that the flow from Wards Island does not pass out through the Narrows but may find its way out to Long Island Sound. I believe the general consensus of opinion is that sewage discharged into the harbor remains there for a long time. Messrs. Phelps and Velz have used figures for the time of passage from the Battery to the Narrows of 5.2 days. The writer, using different conditions and assumptions, has found a figure of 7.75 days. All such computations are, of course, approximations. The entire question of oxygen balances and what is actually taking place in the harbor is most elusive and complex.

Aside from the problems briefly suggested above, the engineering and economic aspects of the local New York problem are not simple. The natural conditions and

splendid waterways that have permitted the city to exist so long without substantial corrective measures are in themselves a barrier to simple solutions in the matter of collection and treatment of sewage. We must pay the penalty in the cost of our program for the intense and costly developments that have been brought about by the development of the city. We find that most of the better sites for sewage treatment works have now been developed for other purposes, and we have been forced to go to locations that in some cases are expensive to develop and that are, in general, much smaller than would be desirable.

These conditions force us to subdivide the city into treatment district areas often somewhat smaller than we could hope for. Naturally, the unit cost of treating sewage is substantially less in a large treatment plant than in small ones. In the matter of personnel costs alone, for example, records of our existing plants indicate that in a plant treating only about 20 mgd, the personnel costs may run as high as $9.00 per million gal, whereas in large plants with flows of about 200 mgd this figure may be about $5.00. In the development of our program, there have, of course, been a number of alternate possibilities considered. Some of the comparisons in the early days included the subdivision of the city into as many as 47 separate treatment districts. Our present plans indicate that this number can be reduced to about 16, and the effort toward consolidation will be carried to the economical limit.

Among the more interesting technical aspects of sewage treatment as applied to our program, are the rapid advances being made in treatment methods. The new processes put forward from time to time must be very carefully scrutinized to make sure that we are keeping abreast of progress. Our requirements here are somewhat different from those in inland cities, and while we feel that we must anticipate rising standards in the required quality of our waters, we feel also that it is only proper to take advantage of the large natural purification which takes place in the harbor. We are definitely working toward modification of present processes that will reduce the cost of secondary treatment and bring the power requirements for this treatment within the amount that can be secured from the sewage itself. There are indications that progress is being made along these lines.

There are many square miles of parks and parkways in the city that require large amounts of fertilizer. One

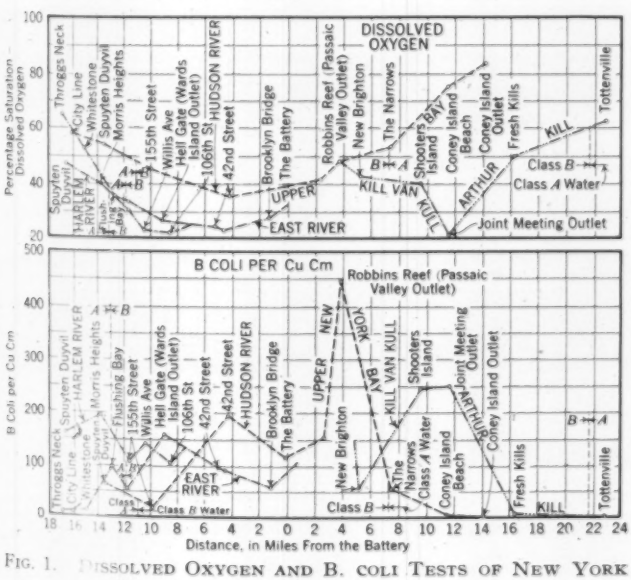


FIG. 1. DISSOLVED OXYGEN AND B. COLI TESTS OF NEW YORK HARBOR WATERS—AVERAGES FOR 1939

of the ultimate objectives of the city, as soon as this is economically feasible, is to recover from the sewage sufficient fertilizer to meet the major requirements.

Although the strictly engineering and scientific problems seem difficult, the really vital problem for New York City (and, as I see it, for most other communities) is the problem of finance. New York is perhaps the wealthiest city in the country and ordinarily spends very large sums of money each year on its public works—over $650,000,000 has been spent in the last 5½ years. The annual operating budget is also large. But unfortunately, it is not different from many smaller cities in that it is close to the limit of its debt-incurring powers for capital works and its annual operating budget is close to the limit that can be legally raised by taxation. The sewage disposal program, while in itself not excessively costly for a city of this size, must compete with other demands for the relatively meager funds available. The problem of financing the construction of new works and their operation has become a serious one.

COST AND FINANCING OF PROGRAM

There is no question in the minds of those who are acquainted with the present situation as regards pollution that the sewage-treatment program should be advanced with the greatest possible speed. The rate of advance will, of course, affect the annual amount of money required for retirement of bonds and interest on indebtedness. Up to the present New York City has spent about $41,000,000 for the construction of new treatment works. Of that amount, approximately $11,800,000 will be returned as a grant from the federal government. In order to furnish treatment for all the sewage, it is estimated that about $148,000,000 additional will be required. Of that amount, approximately $13,000,000 has already been authorized. Studies indicate that the annual charges for debt service and operation for the works under the program will increase gradually to a peak of from 14 to 15 million dollars per year, depending somewhat on the rate at which the program is advanced. After this peak is reached, and upon amortization of the bonds, the cost will drop to that necessary for operation of the works. While the maximum annual expenditure, which may be reached in 10 or 15 years, looks like a substantial addition to the tax levy, it is only a little over 2% of the city's annual expenditures and is certainly not excessive in view of the importance of sewage disposal in the general municipal picture.

The outstanding necessity at the present moment, as I see it, is for the establishment of a definite and assured annual income, from sources other than real estate and taxes, that will permit the prompt and complete solution of the sewage disposal problem. The importance of this problem dictates that it should be divorced from the complexities of the tax levy and capital outlay budgets, with their constitutional limitation as to the amount of expenditure, and the competition of projects that may have a more immediate popular appeal. After all, in spite of all rules and regulations that may be promulgated and beautiful and scientific engineering plans that may be made, the real solution to the problem in the New York area will be the securing of continuous and adequate funds for carrying out the program on an assured and rational basis. Whether the major program is accomplished in 10 years or drags out to 20 years or more will be contingent on the availability of funds. The urgency and importance of restoring the condition of our waters is in my opinion, ample justification for placing the program on a self-sustaining status based on services rendered. For such a procedure there is ample precedent.

Preliminary Engineering at Morenci Open Pit

Preparing for the Development of a 230,000,000-Ton Deposit of Copper Ore in Arizona

A Paper Presented at a Recent Meeting of the Arizona Section

By Walter C. Lawson

Phelps Dodge Corporation, Morenci, Ariz.

WINDING a standard-gage railroad around precipitous bluffs, stripping away 42,000,000 tons of barren rock, and building a modern permanent town to house the workers, are among the preliminary operations required in developing the new open-pit copper mine near Morenci, Ariz. In the accompanying article, Mr. Lawson gives an interesting account of these and other engineering features of the work.

EXISTENCE of a large, low-copper-content ore body about half way between Morenci and Metcalf, in southeastern Arizona, has been known for many years. Its original discovery and subsequent outlining were a natural outgrowth of operations on the wide, high-grade veins that were first mined in the district. This deposit is now being prepared for mining as the Morenci Open Pit, and it is estimated that it will yield 230,000,000 tons of ore containing 1.06% copper.

The Morenci copper mines are among the oldest in the state. Incidentally, the original entry of the Phelps Dodge Corporation into the production of the metal was made there in 1881. To date the combined production of all companies in the district has been about 1,800,000,000 lb of copper, and now it is anticipated that the new development will add 5,000,000,000 lb during the next 30 to 40 years.

Whereas the ore body has been known for a long time to exist, the possibility of its being mined by an open pit has been developed more recently. The advantages of open-pit mining are mostly obvious. First, since all the material within the ultimate boundaries of a pit is handled a little at a time, all the ore can be cleanly separated from the waste, while either dilution of the ore with waste or the recovery of only part of the ore is inherent in most underground methods. Furthermore, it is generally the case that some small zones of mineralization flank the main mineralization and are missed by the big-scale prospecting, but will be exposed and recovered by a stripping operation. These isolated patches of ore are small individually but of appreciable importance in the aggregate, and most likely would forever be unproductive except by shoveling methods.

Also, the low maintenance cost of an open pit is an item of important advantage. During periods of curtailment of production there is little to deteriorate or to be kept in repair—no water to pump and no workings to keep open. Additional advantages are favorable production costs and good flexibility. In these days of variable copper demand, the latter feature of a mine is quite desirable since production can be more easily adjusted to the existing requirements.

All the foregoing discussion points to the desirability of mining with open-pit methods, but so far nothing has been said of the several considerations that must be given to the proposed layouts during the study of the feasibility of applying that method to an ore body.

Inasmuch as the perfectly shaped ore body has never been found, the foremost consideration in an open-pit layout is the quantity of barren waste that must be handled to get the ore out. Consideration must be given not only to the total quantity of waste, but also to the amount that initially must be removed to expose ore. Further, it is important to know whether, after ore is exposed, the production of it can be maintained at a satisfactory rate with a somewhat uniform and consistent rate of stripping. The total amount of waste to move at Morenci is about 230,000,000 tons, or in a ratio of 1 to 1 with the ore. Much of this exists as a barren rock capping overlying the rock containing the copper. The average thickness of this capping before operations were

Courtesy "The Mining Journal"

A General View of the Morenci Open Pit

Ore Switchbacks at Lower Left. Waste Goes to the Right. Development of Benches Can Be Seen at Right Center

started was 216 ft, and the maximum, 500. The character of the rock in the capping and in the ore zone is essentially the same, though the ore possibly is a little softer. In color the capping varies from light brown or rusty to light red, whereas the ore is a light gray. Originally all the rock was mineralized, but with the passing of time the copper in the upper portion has been leached out by downward-percolating cold water and redeposited at lower depths, leaving behind the iron oxides that now give the leached portions the variable brownish or reddish colors.

Another major item of consideration in pit planning is the availability of dump room. Due to the rough topography of the country surrounding the Morenci pit, waste disposal areas are satisfactory. Fairbanks Canyon, which joins the pit on the north, will hold 30 million tons; Coronado Canyon, a little further to the north, will hold 120 million tons; and the remainder will be dumped in Chase Creek Canyon along the haulage way to the mill. The average waste haul distance will be about $2^1/_2$ miles.

CHURN DRILL AT WORK ATOP A PRECIPITOUS BLUFF THAT MUST BE REMOVED FOR RAILROAD CONSTRUCTION

One more essential feature of a workable pit is good physical properties. By the very nature of the mining procedure nothing is permanent within a pit area, since all the working faces are gradually being pushed back. However, to assure constant production it must be possible to locate the tracks from the working faces to the crushers and to the dumps in permanent, or at least nearly permanent, position. The limits of the ore body and the adjacent topography at Morenci permitted of the installation, at the outset, of main ore tracks and main waste tracks all outside the final limits of mining.

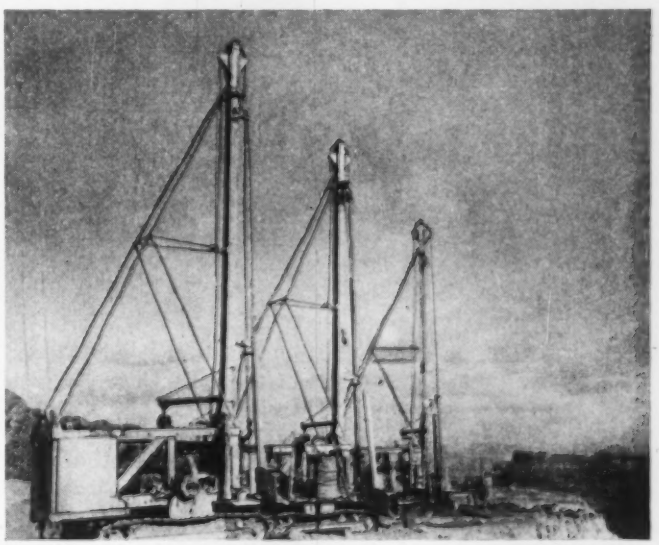
The decision to go ahead with the Morenci development was reached in 1937. From the tonnage figures and description of the barren capping that have previously been given, it is obvious that this mine required advanced stripping. Bearing in mind the desirability of keeping the preliminary waste tonnage to a minimum as well as the need of exposing a small volume of ore for test purposes early in the program, the limits of the preliminary stripping were laid out and the initial attack therein was made with shovels and trucks on benches 50 ft high.

In the present state of development of transportation equipment the established means of haulage, when moving big tonnages over the distances that exist in large pit operations, is locomotives and railroad cars. However, for the early stages of the Morenci development it was believed that trucks, due to their flexibility, would be better suited for the preparation of the mining benches for railroad track. Moreover, a plan was worked out whereby much of the material, as it was removed in this process, would be dumped in the deep, rough canyons where later it could be utilized in the construction of roadbeds for track and thus would reduce to a minimum the amount of railroad excavation needed. Accordingly, a fleet of eighteen 42-ton $22^1/_2$-yd trucks was purchased and put into service. The decision to use the trucks has been fully justified.

In addition to the 18 big trucks, six $4^1/_2$-yd electric shovels, twelve 9-in. churn drills, 4 pneumatic toehole drills, 18 jackhammers, 4 bulldozers, 1 road grader, 1 sprinkler truck, and 2 specially equipped service trucks are at present available for the stripping operations. For railroad construction, delivery of test ore to an experimental plant, and townsite and plant-site preparation, the following equipment is available: 5 diesel shovels varying in size from $^3/_4$ yd to $1^1/_2$ yd, nineteen 5-yd trucks, 5 bulldozers, 1 carrying-type scraper, 1 dirt tamper, and 20 jackhammers. Completely fitted shops are maintained for repairing and servicing all this equipment.

Production by trucks has been augmented by rail haulage since July 1 of the current year. Waste haulage from the upper benches is over a series of tracks laid on 0.2% grade built especially for that purpose in an opposite direction to the proposed ore movement. The ore will be hauled to the pit edge over a series of four switchbacks on 4.0% compensated grade for 2 miles, then on main line track with 0.4% grade for $1^1/_3$ miles to the crusher. Curvature on main tracks does not exceed 8 degrees. The average ore haul will be about 3 miles.

Switchback and main line rail is 131-lb section laid on 8 by 10-in. creosoted cross-ties. Bench and dump

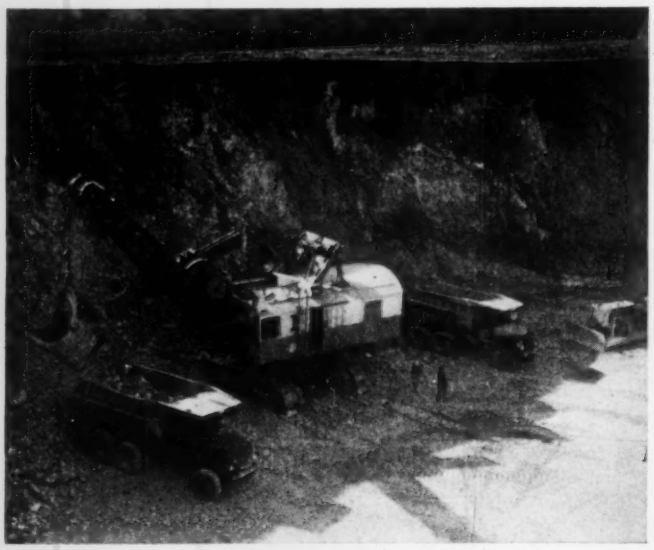


A BATTERY OF 9-IN. DIAMETER CHURN DRILLS DRILLING BLAST HOLES NEAR THE EDGE OF A 50-FT BANK

PORTION OF THE NEW TOWN BEING BUILT FOR EMPLOYEES AT MORENCI OPEN PIT; ALL HOUSES ARE COMPLETELY MODERN

rail will be 90-lb section on 7 by 9-in. cross-ties. Cars for waste will have a capacity of 30 cu yd and be of the self-dumping, drop-door type. Ore cars will be similar but probably of slightly greater capacity. Diesel-electric locomotives will be used on the upper waste benches, while the switchbacks and main haulage way will be electrified for trolley locomotives. At this point it is interesting to observe that the first railroad in Arizona was built in Morenci in the year 1878. The locomotives that ran on it were 20-in. gage, weighed 6 tons, and came from Yuma by ox-team. Now, 62 years later, the mines have grown to where standard gage, 130-ton, 1,400-hp units will soon start to play their part in the never-ending development.

Construction of the track roadbed from the plant site to the pit has been one of the most interesting engineering phases of the pit development. The switchbacks near the pit are in a rugged canyon, and are built mostly on fill dumped there by the big truck operations according to predetermined plans. From the bottom of the switchbacks to the crusher the alinement followed along a series of 200-ft quartzite bluffs. This position for the main haulage track was desirable due to the topography



A 4½-YD ELECTRIC SHOVEL LOADING 22½-YD DUMP TRUCKS
Note Trucks on Each Side of Shovel, and Bulldozer Keeping Roadway Clear

near the pit area, accessibility of trackage to the lower benches, and elevation of the crusher. The track system as laid out will permit of the movement over favorable grades of 85% of the material to be handled.

The topography of the main haulage section of the roadway was so rough and precipitous that the usual surveying procedure for location was quite impossible. The study and layout therefore, as well as the control of construction, were all made and maintained through the use of a very comprehensive system of triangulation stations placed along the edges of the bluffs and on any points that existed nearer to the roadbed grade. By using heavy curvature it was possible to carve a narrow track roadbed along the side of the bluffs. This will all be lined out into good operating position before ore production starts, by dumping mine waste into the intervening canyons from rail cars.

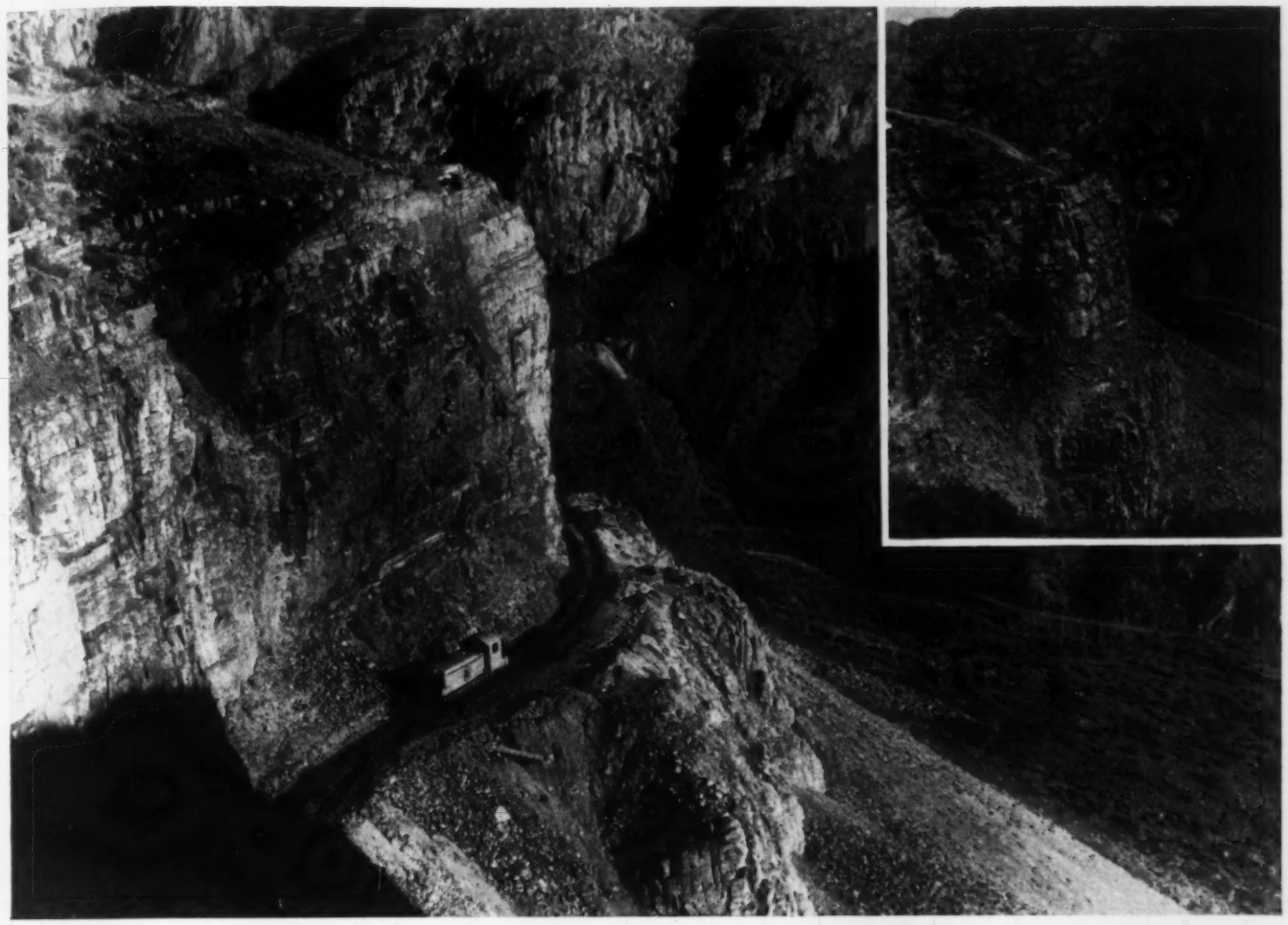
TRACK WIDENING, TOWN BUILDING, AND OTHER PROJECTS

Apart from the pit development itself, a number of allied projects were necessary. One of the early jobs required the changing over of the company's Clifton-Morenci industrial railroad from narrow-gage to standard-gage track so that heavy equipment could be brought in. Moreover, since the terminus of the railroad was 1½ miles from the pit, the connecting road through the main part of Morenci required widening and grading. A diamond drilling program was put under way to explore dumping areas.

One of the foremost needs of the community was houses for the workmen. During the latter part of 1937, ground was broken for 50 houses in a new town site, and this has since been expanded to 179 units providing occupancies for 220 families. The houses are completely modern, of 4-, 5-, and 6-room design, varying in arrangement and appearance. All of them are equipped with copper roofs and copper piping, and in some of the more recent houses the metal window sash and the concrete floors are finished with copper paint.

Another item of singular interest to engineers came up in regard to the property ownership and boundaries. A thorough and exhaustive study of the mining claim plats in and near the areas of proposed dumps brought to light the existence of several tiny fractions of open ground that, in some instances, were so small as not to be acknowledged on existing maps by the U.S. Land Office. Entirely surrounded by patented mining claims one of the smallest of these "slivers," triangular in shape, was 1 in. wide at the base by 60 ft long. Later when this piece was inspected by a mineral examiner, he truly had to step off the land to see it.

Preliminary stripping required to prepare the pit for ore production has been estimated to be about 42,000,000 tons. More than one-half of this has been moved to date (August 1, 1940). Thirteen mining benches have been established in whole or in part. According to the present schedule a new plant, consisting of crushing units, concentrator, smelter, and power house, will be erected and ready for production in January 1942, by which time the mining of the remainder of the preliminary tonnage will have been completed.



"BEFORE" (INSET, UPPER RIGHT) AND "AFTER" VIEWS OF RAILROAD CONSTRUCTION
Later, Sharp Curvature Will Be Eliminated by Dumping Mine Waste in the Canyons and Moving Track to the New Fill

VIEWS OF THE SWITCHBACKS. THESE TRACKS, ON 4% GRADE, ARE MOSTLY BUILT ON FILL DUMPED FROM THE 22½-YD TRUCKS

Roger Sherman, Colonial Surveyór

Some Historical Notes About an Important Early American Surveyor and His Valuable Textbook, of Special Interest to Civil Engineers

By Edward Dyer Kingman

Associate Member American Society of Civil Engineers
Head, Department of Applied Mechanics and Materials of Construction, Wentworth Institute, Boston, Mass.

FROM 1743 to 1760 Roger Sherman was active as a surveyor in Connecticut. But it is not solely this activity, nor the fact that he was among the signers of the Declaration of Independence and the Constitution, that makes him of special interest to engineers. It is more especially that he possessed a copy of Norwood's "Epitome," one of the first important books on surveying printed in English, and in it made notes of his own which constitute a comprehensive treatise on land surveying as practiced in his day.

A RECENT investigation into early technical Americana has revealed a copy of Richard Norwood's *Epitome, or the Doctrine of Triangles*, which was formerly the property of Roger Sherman, surveyor, statesman, and patriot. It was Sherman, be it remembered, who at the conclusion of the War for Independence emerged as one of the outstanding figures in public life in the newly created United States. He was the only signer of all four of the fundamental documents—the Articles of Association, 1774; the Declaration of Independence, 1776; the Articles of Confederation, 1777; and the Federal Constitution, 1787.

Sherman was active as a surveyor in Connecticut from 1743 to circa 1760. During a long and busy life he continued his study of mathematics, gaining considerable reputation as a philomath for the compilation of almanacs, which were based for the most part on his own observations and calculations. Throughout his career, the *Epitome* was his guide, and this copy of it is of special interest to civil engineers because of the copious notes he inscribed in it. This volume, now in possession of the Historical and Natural History Society of Framingham, Mass., was published by Leybourn in London in 1659.

NORWOOD AND HIS FAMOUS TREATISE

In compiling the data in this book, Norwood was able to draw from his experience as the first surveyor and draftsman assigned to the English Colonies. He was a member of the Moore party, which arrived at the Summer Isles (now called the Bermudas) in 1612. As he had some previous training in surveying, he was given the post of "surveyor of the isles." In 1622 appeared the first map of any part of the English Colonies situated in the New World, a map that in 1627 was incorporated in Capt. John Smith's *History of Virginia, New England, and the Summer Isles from 1584–1626*. Norwood's name in the lower right-hand corner attests his authorship, and the quality of the drawing shows him to have had considerable skill as a draftsman. It is interesting to note that Norwood may have been offered the post of "surveyor of the Virginias," as his name later appeared on the original lists of patentees. However, long search has failed to reveal that he came to Virginia; instead, he appears to have taken up permanent residence in Bermuda, where he practiced the art of surveying off and on throughout a long life.

It may be of interest to mention that a number of surveyors assigned to work in the early period of English colonization returned to England and wrote important treatises on the art of surveying. In this period also, surveying was frequently explained in some detail in texts on geometry and trigonometry, and even in the old arithmetics.

Among books dealing with surveying published in England, the first title that comes to mind is Folkingham's *Synopsis*, a handbook published in 1610, giving a few rules for land measure, land drainage, hints on manuring, rules for simple arithmetic, and so forth, but in no sense a treatise on surveying. Therefore Norwood's book, printed in 1659, might be considered one of the first important treatises on surveying printed in English. (See accompanying list.)

As to the copy of Norwood's *Epitome* possessed by Roger Sherman, one can only surmise how it came to him, but it seems probable that it descended from one of his

Early Books on Surveying

English Books Circulated in the Colonies

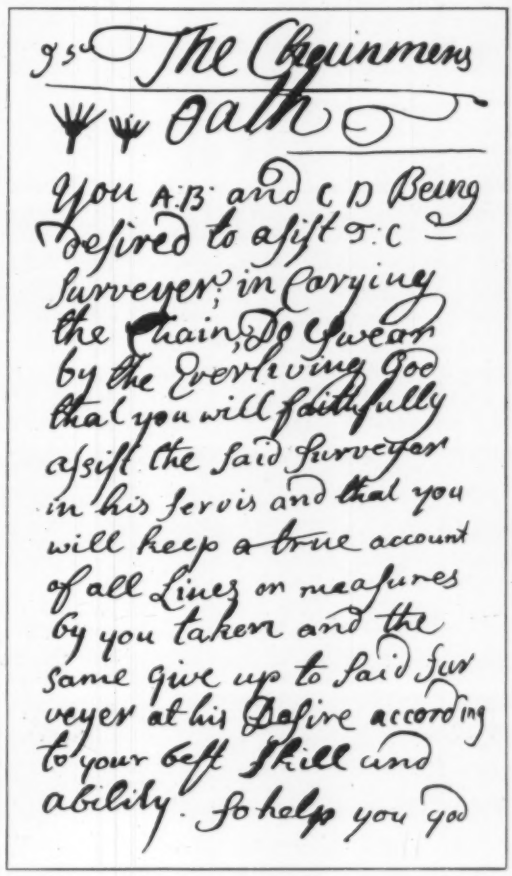
Folkingham's *Synopsis*, or *Epitome of Surveying Methodized*, Moore, London, 1610
Norwood's *Epitome*, Leybourn, London, 1659
Love's *Geodesia*, London, 1688 (Philadelphia imprint dated 1793)
Wilson's *Surveying*, London, 1731
Hammond's *Surveying*, London, 1731
Gibson's *Surveying*, London, circa 1780 (American editions, beginning 1785)

American Books

Gordon's *Mathematical Traverse Tables*, W. Dunlap, Philadelphia, 1758
Moody's *Compendium of the Art of Surveying*, I. Collins, Burlington, N.J., 1771
Clendinin's *Practical Surveyor's Assistant* (Tables), published by author, Philadelphia, 1793
Redfield's *Surveying*, Hartford, Conn., 1796
Moore's *Surveying*, Thomas Collier, Litchfield, Conn., 1796
Jess's *Compendious System of Art of Surveying*, Bonsal and Niles, Wilmington, Del., 1799
Dewey's *Short and Easy Method of Surveying*, E. Babcock, Hartford, Conn., 1799
Flint's *Surveying*, Lincoln and Gleason, Hartford, Conn., 1804
Gummere's *Surveying*, Kimber and Sharpless, Philadelphia, 1814
Day's *Principles of Navigation and Surveying*, Steele and Gray, New Haven, 1817

forebears. For instance, it might have come from a Rev. John sherman, a contemporary of Norwood in England, and a philomath of repute who emigrated to Watertown, Mass., in 1634, and at intervals in a crowded life wrote and lectured on "the mathematicks." Or it might have come down from a Capt. John Sherman, also immigrant to Watertown, Mass., in the year 1636, a cousin of the previously mentioned Rev. John Sherman, and like him a lover of mathematics. This Captain Sherman was a surveyor by occupation. At his death he left an estate which included a library valued at £5, and surveying instruments valued at another £5. The latter descended to his son Joseph, also a surveyor and the grandfather of Roger Sherman. This surmise is reasonable in view of the tastes of a succession of Shermans which, in the first four generations in the Colonies, produced three land surveyors.

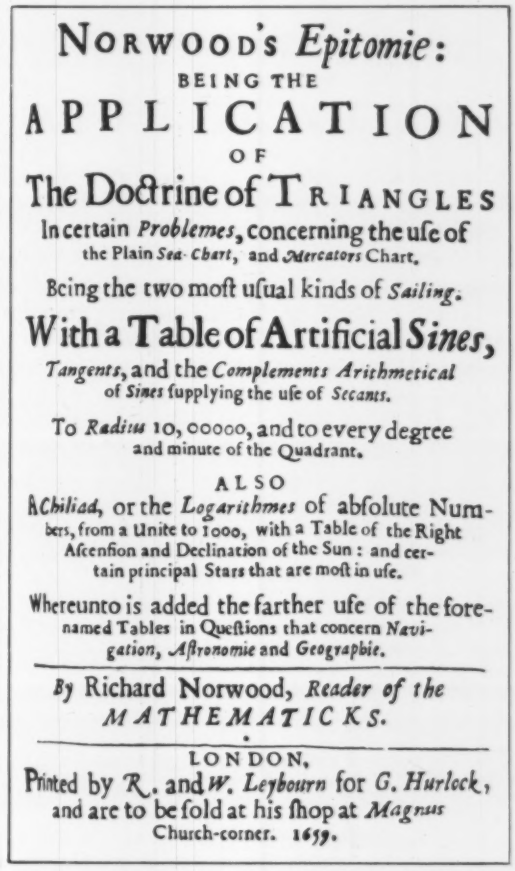
Roger Sherman (1721–1793) was born in Newton, Mass., and when about twenty years of age migrated to New Milford, Conn., where he engaged in land surveying from 1743 to circa 1752. He was appointed a deputy-surveyor of Connecticut and assigned to surveys in the Litchfield county area, and here he was active in land development, civic affairs, and legislative duties. After 1760 the latter came to occupy so much of his time that he relinquished his surveying work.



95 The Chainmens Oath

You A:B: and C D Being desired to assist E:C Surveyer; in carrying the Chain, Do Swear by the Everliving God that you will faithfully assist the said Surveyer in his Servis and that you will keep a true account of all Lines or measures by you taken and the same give up to said Surveyer at his Desire according to your best Skill and ability. So help you God

THE CHAINMAN'S OATH, INSCRIBED BY ROGER SHERMAN IN HIS COPY OF NORWOOD'S *Epitome*



NORWOOD'S *Epitomie*:
BEING THE
APPLICATION
OF
The Doctrine of TRIANGLES
In certain *Problemes*, concerning the uſe of the Plain *Sea-Chart*, and *Mercators* Chart.
Being the two moſt uſual kinds of *Sailing*.
With a Table of Artificial *Sines*,
Tangents, and the *Complements Arithmetical* of *Sines* ſupplying the uſe of *Secants*.
To *Radius* 10, 00000, and to every degree and minute of the Quadrant.
ALSO
A *Chiliad*, or the *Logarithmes* of abſolute Numbers, from a Unite to 1000, with a Table of the Right Aſcenſion and Declination of the Sun: and certain principal Stars that are moſt in uſe.
Whereunto is added the farther uſe of the forenamed Tables in Queſtions that concern *Navigation*, *Aſtronomie* and *Geographie*.
By Richard Norwood, *Reader of the* MATHEMATICKS.
LONDON,
Printed by *R.* and *W. Leybourn* for *G. Hurlock*, and are to be ſold at his ſhop at *Magnus* Church-corner. 1659.

TITLE PAGE OF ROGER SHERMAN'S COPY OF NORWOOD'S *Epitome*, ONE OF THE OLDEST BOOKS IN ENGLISH FOR SURVEYORS

As put together by the printer, Norwood's *Epitome* consisted of 197 pages, of which 108 contained formulas and practical problems related to the location of courses on sea or land. The scope of these problems is very wide, and so clear are the explanations of "how to do it," and so useful the accompanying tables, that it is evident this small tome must have been very helpful to its owner. In addition to these 108 pages there are 89 pages that were left blank for the purpose of providing space for notes, and it is on these pages that Sherman inscribed in considerable detail, in bold handwriting under his own signature, what amounts to a comprehensive treatise on the art of land surveying. Some of the page headings are: "How to lay out land in various shapes and areas"; "How to divide a triangle and other figures"; "How to record field notes"; "How to compute the course of a line"; and "How to use tables of functions."

Also there are numerous references to surveying work that Sherman did; jottings of dates and places, the courses of routes about Farmington, Southington, Simsbury, Little Plain, and other localities west of Hartford; and the names of prominent landowners with dates from 1756 to 1760 as memoranda. Of more than passing interest is inscribed a "chainman's oath" which Sherman may have required from members of his party, for it is well known that he was most meticulous in such matters. In one place he wrote, "For several years past, for my own amusement I have spent some time of my leisure in the study of mathematics. I have taken care to perform all calculations truly."

LITCHFIELD, CONN., A CRADLE OF EARLY AMERICAN SURVEYING BOOKS

In view of the history of surveying subsequent to Sherman's career in the Litchfield district, one is tempted to credit him, and through him his copy of Norwood's *Epitome*, with some influence on the genesis of surveying literature in this country. It is very probable that Sherman was acquainted with Samuel Moore, for thirty years a surveyor in the Litchfield district and a philomath of local repute. Moore is credited with compiling the first comprehensive American text on surveying (1796). Though published in 1804, several years after the death of Sherman, Rev. Abel Flint's *Surveying* was, states the author, "based on well known current sources," of which Moore's book was one. Further, Moore, Flint, and Jeremiah Day, the latter author of *Principles of Navigation and Surveying* (1817), all contemporaries of Sherman—Day was his son-in-law—gained a first-hand knowledge of the art of land surveying in the western Connecticut district. Litchfield has been called "the cradle of American law schools." This locality also may reasonably be labeled "a cradle of early American surveying books."

The Pecos River Joint Investigation

Comprehensive Governmental Survey and Analysis of the Basin's Water Resources and Problems Now Under Way

By HARLOWE M. STAFFORD, M. AM. SOC. C.E.

ENGINEER-IN-CHARGE, PECOS RIVER JOINT INVESTIGATION, AND COUNSELOR OF REGION 7, NATIONAL RESOURCES PLANNING BOARD, ROSWELL, N.MEX.

INCREASINGLY acute problems connected with water quantity, quality, and use in the Pecos River basin of New Mexico and Texas, have made necessary a general comprehensive investigation and report to furnish the basis, primarily, for an interstate water compact. How this is being done as a cooperative undertaking of federal and state agencies is an interesting story. The work, here described, includes studies of runoff, consumptive use of water, control of floods, erosion, silting, and salinity.

IN recent years the western states have witnessed increasing difficulties and controversies over interstate waters. On a number of interstate streams the difficulties have resulted in extended and costly litigation before the U.S. Supreme Court, and in some cases an equitable settlement is still far away.

With the difficulties attendant upon litigation, and the apparent lack of adaptability of this process to the bringing about of a satisfactory solution of interstate water problems, the states have begun, more and more, to give consideration to the compact method. Under this method, the essential procedure is first a thorough fact-finding investigation and then an agreement among the official representatives of the states concerned as to the most equitable allocation of the waters of the stream between such states.

VALUE OF IMPARTIAL FACT-FINDING AGENCY

As between different streams and situations there may be considerable variation in the agencies and methods employed to make the fact-finding investigation. In some cases the interested parties, with nominal help from governmental agencies engaged in the collection of hydrologic and meteorologic data, have been able to make the investigations necessary for the formulation of an agreement between them. In other cases, while much work may be done by the interested agencies, yet the conclusions of that work may not be accepted by each of the interested parties as a proper foundation for an agreement. In such cases it is desirable for the fact-finding investigation to be made by an impartial agency.

Like the Rio Grande Joint Investigation, which was completed in June 1937, the investigation of the Pecos River basin constitutes an attack on another difficult interstate water problem. The Rio Grande experience indicated the desirability of a cooperative undertaking participated in by all interests concerned, under the leadership of an impartial federal agency. The Rio Grande Investigation presented in clear relief the nature and magnitude of the problems involved. It is notable that in the solution of these problems the contesting states clearly recognized their mutual obligations, and for the first time in history joined with one another and with the federal government in an effort to find a satisfactory factual basis for allocation of the water.

With water problems in the Pecos River basin ever more pressing, and the successful consummation of an interstate compact on the Rio Grande fresh in mind, it seems but natural that the interests concerned in the Pecos basin should have turned to methods similar to those employed on the Rio Grande, to work out a solution of their problems.

The Pecos River drains an area of some 39,000 sq miles—22,000 in New Mexico and 17,000 in Texas. It rises on the east slope of the Sangre de Cristo Mountains northeast of Santa Fe, N.Mex., and flows in a southeasterly and southerly direction for 435 miles in eastern New Mexico, and southeasterly for 320 miles in southwest Texas to its confluence with the Rio Grande. Altitudes range from more than 13,000 ft at the headwaters to 1,000 ft at the mouth. Figure 1 is a map of the watershed area.

Roughly, the total of the irrigated area in the basin is between 250,000 and 300,000 acres. In New Mexico a total of about 95,000 acres is irrigated from the Pecos River and tributaries, including 25,000 acres on the Carlsbad Project; and about 85,000 acres are irrigated from artesian and shallow ground-water sources in the area of the Roswell artesian basin. In Texas, the area irrigated from the Pecos River is about 50,000 acres, and the remainder of the irrigated area is served from tributaries, springs, and ground water. The principal storage reservoirs, all on the main river, are the Alamogordo and McMillan serving the Carlsbad Project, and the Red Bluff serving the Red Bluff District in Texas.

HISTORICAL DEVELOPMENT OF WATER USE

Except for the small valleys along the upper reaches of the river above Santa Rosa, where irrigation under community ditch systems began at a very early date, the Pecos River valley, until the late 1880's, was all cattle country. Along the river, however, settlers began to irrigate lands about 1888, when the Pecos Valley Land and Irrigation Company was formed and the construction of irrigation works in the vicinity of Roswell and Carlsbad was commenced. Two years later the Pecos Irrigation and Improvement Company was organized, resulting in the development of the Hagerman, Carlsbad, and Harroun projects.

About 1907 the Carlsbad Project was in difficulties from leakage in Lake McMillan, its storage reservoir, and from loss of its secondary storage and canal diversion, Lake Avalon, by washout of the dam. At this time the

Bureau of Reclamation Photo

THE ALAMOGORDO DAM, COMPLETED IN 1937, IS ONE OF THE THREE PRINCIPAL STORAGE RESERVOIRS ON THE PECOS RIVER

Department of the Interior, through the Reclamation Service, took over the project and reconstructed the dams and irrigation works. It has operated the project to date. Difficulties continued with the leakage in Lake McMillan and the great loss of capacity due to silting, such that it became necessary to seek additional storage. As a result, the Alamogordo Reservoir—near Ft. Sumner and 175 miles by river above Carlsbad—was constructed in 1936–1937. This reservoir is designed to furnish the regulated water supply required on the Carlsbad Project, replacing the lost storage in McMillan Reservoir. The present Ft. Sumner Project was begun in 1906 and first delivered water in 1907.

One of the earliest projects of the Reclamation Service was the Hondo Reservoir on the Rio Hondo near Roswell, which was constructed about 1905. This project was a failure, however, because of the excessive leakage which developed from the reservoir into the soluble underground strata.

Since flowing wells were first struck near Roswell about 1896, underground water has been extensively developed in the artesian belt extending from some five miles north of Roswell to Seven Rivers. A few years ago, when this underground source of water was seriously threatened by overdraft, a state law was enacted and enforced under which the State Engineer prohibits any expansion in use which will constitute an overdraft.

In the Pecos Valley of Texas, according to reports, the first irrigation ditch was built by the Pecos River Irrigation Company in 1875. By 1914 work had been begun or completed on ten projects taking water from the river. These projects were dependent entirely on the erratic natural flow of the river, and by 1934 substantial acreages originally included in the projects had gone out of cultivation either because of serious water shortages or because of the high salt content of the river water at certain stages. As a means of rehabilitating these Texas projects, the Red Bluff Reservoir on the Pecos River at the New Mexico–Texas state line was completed in 1937 by the Red Bluff Water Power Control District with a PWA loan and grant.

With all this development, many increasingly acute problems have arisen, mainly concerned with the quantity and quality of the available water supply, with the erosion and the silting of channels and reservoirs, and with floods and their control.

Differences have existed for many years between the states of New Mexico and Texas over the use and control of Pecos River waters. Texas interests vigorously opposed the construction of the Alamogordo Reservoir as in conflict with the interests and rights of the Red Bluff Project, and only consented to its construction after agreement by the New Mexico interests concerned that "New Mexico would not cause or suffer Texas to be deprived in the future of the same proportion of the flood waters originating above Avalon Dam which had passed Avalon Dam during the past twenty years."

SALT CONTENT A MAJOR PROBLEM

One of the major irrigation problems, that of concentrations of mineral salts in the river waters, is extremely accentuated throughout the Pecos River basin, but particularly so in the lower reaches, from the Carlsbad Project on down into Texas. In the vicinity of the Malaga Bend, south of Carlsbad, there are springs of pure salt brine flowing into the river and contributing thousands of tons of salt annually to its waters. The United States Potash Company has been sued by water users alleging that the company's waste salts, discharged into an old salt lake near its refinery, were the cause of an increase in the salinity of the river water. Although the jury's finding in favor of the plaintiffs was later set aside, the case is illustrative of the serious situation under which the future of this potash industry, of nation-wide importance, might be threatened.

Roswell faces a serious flood problem in the control of the Rio Hondo floods. Following the disastrous floods of June 1937, efforts were made to secure federal funds for a flood control project, and many proposals for such a project have been made. These are based largely on the use of the old Hondo Reservoir as a detention reservoir. Texas interests have vigorously opposed this, claiming that it would involve conversion of flood waters to underflow and to the underground basin—waters that might otherwise reach, and furnish much needed fresh supplies to, the Red Bluff Reservoir.

ATTACKING THE PROBLEM

With the solution of these problems becoming increasingly urgent and in view of the complexity of the interests involved—federal, state, and local—Harold L. Ickes, as Secretary of the Interior, on February 9, 1939, addressed a letter to the Chairman of the National Resources Planning Board, requesting the Board to organize and supervise such a general investigation of the water and other related problems of the Pecos basin as would permit recommendations of programs of action.

Following this request the Board called a conference which was held at El Paso, on March 20–21, 1939, attended by representatives of all the federal agencies involved, of the states of New Mexico and Texas, and of the various local interests. The plans were laid at this conference for the Pecos River Joint Investigation as a cooperative undertaking of federal and state agencies under the leadership of the National Resources Planning Board. By July the necessary financing was worked out, and field headquarters for the National Resources Planning Board were established at Roswell.

The objective of the Pecos River Joint Investigation is to develop factual information that may serve primarily as the basis for negotiating a compact between the states of New Mexico and Texas to provide for the equitable division of Pecos waters between the states; and secondly, as the foundation for remedial action on the pressing problem of salinity, the locally critical problem of floods, the problem of silting, and in general as the foundation for the orderly development and effective utilization of the land and water resources of the basin.

The different phases of the work are being conducted by three major federal agencies—the U.S. Geological Survey, Department of Agriculture, and Corps of Engineers of the War Department. The Geological Survey is investigating surface and underground waters and their quality. The Department of Agriculture is studying the use and consumption of water, the mapping of

Bureau of Reclamation Photo

AVALON DAM SPILLWAY, CARLSBAD PROJECT

irrigated and water-consuming areas, flood control from the standpoint of runoff retardation and soil-erosion prevention in the watershed, erosion and silting, and crop tolerances and water requirements for the successful use of irrigation waters of high salinity. The Corps of Engineers is conducting a detailed flood control survey of the basin, under the Federal Flood Control Act, including floods and flood damage and the feasibility of reservoirs and channel improvements for flood control and allied purposes.

In addition to coordinating the work of the participating agencies, the office of the Engineer-in-Charge of the Pecos River Joint Investigation is concerned with the necessary water supply and over-all studies needed to supplement the work of the other agencies in the preparation of the final summary report of analyses and findings. This includes also the preparation of general and detailed base maps for the common use of all agencies. Work in progress entails the compilation of all runoff records; extension of the records for key stations to cover a base, 35-year period, 1905 to 1939; determination of past stream-flow depletion in the major areas of water consumption between key gaging stations, as the basis for correcting past runoff at those stations for present development; estimates of total water production, 1905–1939, segregated to the upper, middle, and lower basins and subdivisions thereof; detailed analysis of river gains and losses as elements in, and the basis for, subsequent operation studies; and finally, after determination of the consumptive requirements and diversion demands of the major irrigation units, analyses to show the availability and use of water under given sets of conditions, present and future, with respect to storage, draft, and any proposed measures for the control of floods, erosion, silting, and salinity, or for water conservation.

In the work of the Geological Survey, the Surface Water Division has made provision for the measurements to give the complete picture on runoff and river diversions and the essential data on drainage and waste waters. In addition to the stations already operating at the beginning of the investigation, some 90 or more new stations have been installed and placed in operation. The program of the Ground Water Division involves the study of ground-water conditions and potentialities, chiefly in the Roswell, Carlsbad–Malaga, and Red Bluff–Girvin areas. Observations of ground-water levels and movement are being made at the many existing wells and at a great number of new wells put down for this investigation. Particular emphasis is being given to the relation of the geology and ground-water movements to the sources and occurrence of waters of high salinity, directed to the possibility, under such conditions as occur at Malaga Bend, of measures to reduce the natural salt inflow to the river. Closely correlated with the surface and ground-water work, the Quality of Water Division is well established in its comprehensive program of sampling and analyzing surface and ground waters throughout the basin. In the period from July 1, 1939, to March 31, 1940, some 3,000 samples had been analyzed.

Various agencies of the Department of Agriculture are engaged in the investigation. A study is being made by the Bureau of Agricultural Economics to furnish particularly the history of irrigation development in the basin. This is nearly completed.

The Division of Irrigation, Soil Conservation Service, is making an intensive study of the consumptive use of water and consumptive requirements. On this work 9 evaporation stations have been established in cooperation with the Weather Bureau. In addition to the usual standard pan and equipment, each station includes also a tule tank. An evapo-transpiration station established at Carlsbad includes tanks for the measurement of water consumption by tamerisk or salt cedar (of which there are tremendous growths along certain stretches of the Pecos River), sacaton, salt grass, and tule. To arrive at consumptive use in another way, provision has been made for the measurement of all inflow and outflow as well as increment or decrement of ground water on three large irrigation units—the Fort Sumner Irrigation District area in the upper part of the basin, the Carlsbad Project area in the middle basin, and the Imperial-Zimmerman area in the lower basin.

Also under the Division of Irrigation, Soil Conservation Service, a

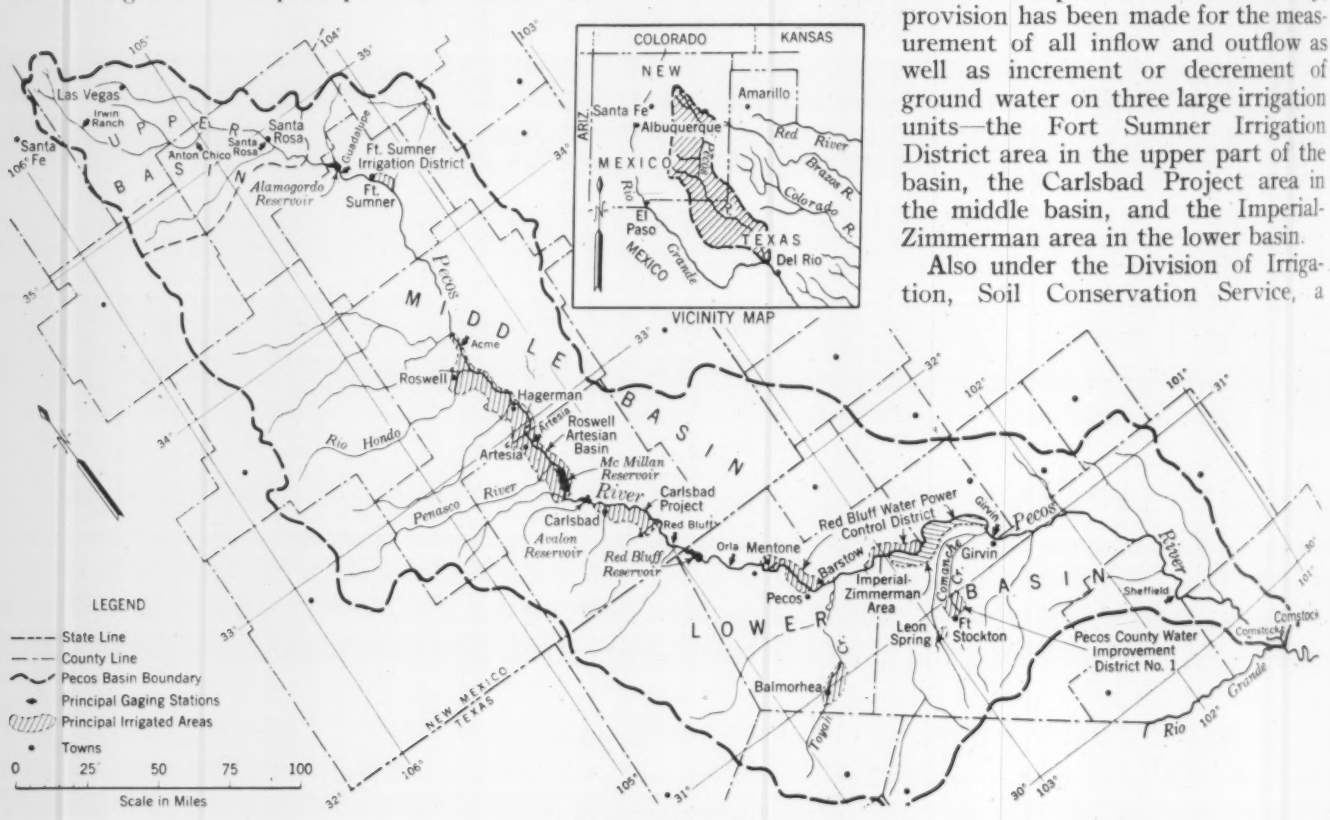


FIG. 1. MAP OF PECOS RIVER AREA

study is being made of drainage problems and needs in the Texas irrigation districts along the Pecos River from Mentone to Girvin. Drainage in this area is of particular importance in its relation to high salinity in irrigation waters and in soil solutions. The study therefore is being closely integrated with the salinity and ground-water investigations in this area by the Bureau of Plant Industry and Geological Survey.

Under the Soil Conservation Service, the field mapping of all water-consuming areas in the valleys is in progress. This survey, begun with the 1940 irrigation season, identifies the lands under 16 crop and other classifications, using field prints on a scale of 2 in. to the mile, as obtained from the aerial survey of the Pecos Basin which was completed in March 1940. The data will furnish the classified acreages in areal subdivisions, to which subsequently determined figures for unit consumptive use may be applied to derive total consumptive use of water.

The Weather Bureau has undertaken to organize, and report on, all climatological data for the basin. This includes tabulation and analysis of all precipitation, temperature, evaporation, and related data. Much of this work is now completed.

The Bureau of Plant Industry is making special studies of salinity in the irrigated soils of the middle and lower basins. Field and office studies under way are designed to ascertain the concentration and composition of the soil solutions associated with limits of

MAIN CANAL OF THE CARLSBAD PROJECT, BUREAU OF RECLAMATION, AT AVALON DAM ON PECOS RIVER, N.MEX

tolerance for the major crops, facts with respect to subsoil permeability and root-zone leaching as related to the use of the saline waters available, and the quantities of irrigation water required to restore and maintain concentrations of salinity low enough to make crop growth feasible. Numerous soil samples are being taken and analyzed at the Pecos laboratory to determine the concentration of the soil solutions throughout the irrigated areas where the problem of salinity is critical.

A survey under the direction of the Field Flood Control Coordinating Committee, with participation by the Bureau of Agricultural Economics, the Soil Conservation Service, and the Forest Service, has been under way since the fall of 1939. As contributing particularly to the information needed by the Pecos River Joint Investigation, it includes: determination of flood and siltation damages, the remedial measures indicated, and the benefits to be derived from those measures; determination of silt sources, critical silt areas, treatments for them, and the relationship of watershed erosion to stream salinity; and the extent and rate of reservoir silting. To date, much of the field work on soil mapping and range surveys has been completed, and the compilation and analysis of damage and economic data, hydrological studies, and designs for remedial measures are well along.

In carrying out the survey of the Pecos River Basin for flood control and allied purposes, the Corps of Engi-

A POTASH MINE NEAR CARLSBAD, N.MEX.

neers, U.S. War Department, is following a comprehensive plan which considers all features of possible reservoirs and channel improvements for the control of floods and the relation of such improvements to water conservation. The principal problem areas included in the field surveys and the economic studies are: the Pecos River and tributaries above Santa Rosa; the Alamogordo Reservoir and Fort Sumner Irrigation District; the Rio Hondo and Roswell area; the Carlsbad Project area; the Red Bluff District area from Red Bluff Dam to Girvin; the Comanche Creek area near Fort Stockton; and the Toyah Creek area near Balmorhea. Survey parties have been in the field for many months and much of the field work has been completed. The economic studies have been carried on concurrently, and the collection and coordination of all data for the preparation of the report is well along.

Total contributions to the expense of the investigation amount to more than $400,000. Of this, the National Resources Planning Board is contributing $100,000 made available through a PWA allocation, the states of New Mexico and Texas are each contributing $30,000, and the remainder represents the contributions of the participating federal agencies, including $38,000 from the Bureau of Reclamation applied on the work of the Geological Survey.

It is contemplated that practically all field work will be completed during 1940 and that the report should be available by June 30, 1941. To the States of New Mexico and Texas will come, then, the problem of working out an equitable compact, based on the data and findings of the report.

The Pecos River Joint Investigation is an activity coming under the Water Resources Committee of the National Resources Planning Board. Charles W. Eliot, 2d, is director of the Planning Board, and Abel Wolman, M. Am. Soc. C.E., is chairman of the Water Resources Committee. The consulting board designated by the Water Resources Committee to direct the investigation comprises Harlan H. Barrows, University of Chicago, chairman; Earl O. Mills, regional counselor, N.R.P.B., Dallas; R. J. Tipton, water consultant, Denver; and Baldwin M. Woods, regional chairman, N.R.P.B., Berkeley. At the Roswell headquarters of the N.R.P.B., the writer is engineer-in-charge; Fred C. Scobey, M. Am. Soc. C.E., is associate engineer-in-charge, and also, as principal irrigation engineer, is field representative of the Department of Agriculture for all phases of the investigation assigned to that department; and Robert L. Lowry, Jr., Assoc. M. Am. Soc. C.E., is hydraulic engineer.

Low-Cost Roads in Kansas

Experience with "Light-Type" and Penetration Surfaces, Bituminous Mats, and Stabilized Bases

By R. B. WILLS

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STATE HIGHWAY ENGINEER, STATE HIGHWAY COMMISSION OF KANSAS, TOPEKA, KANS.

MOST of Kansas' 10,000-mile state highway system has been developed within the last 10 years. "Light-type" surfacing came first, to provide a large mileage of travelable roads quickly and at the lowest possible cost. Then followed a wide variety of penetration surfaces and oil mats, as the demands of traffic became more exacting. In all, some 7,000 miles of these low-cost highways are now included in the state system. Mr. Wills' article describing their development is abridged from his paper before the Highway Division at the 1940 Spring Meeting in Kansas City.

PRIOR to 1929 practically nothing in the way of a connected system of roads existed in Kansas. All highways were under the direct control of county commissioners, who in turn were under the supervision of the highway department. Under this set-up work had proceeded in hit-or-miss fashion, with individual counties scattering their projects here and there, as funds became available, with little attention to the development of a continuous network.

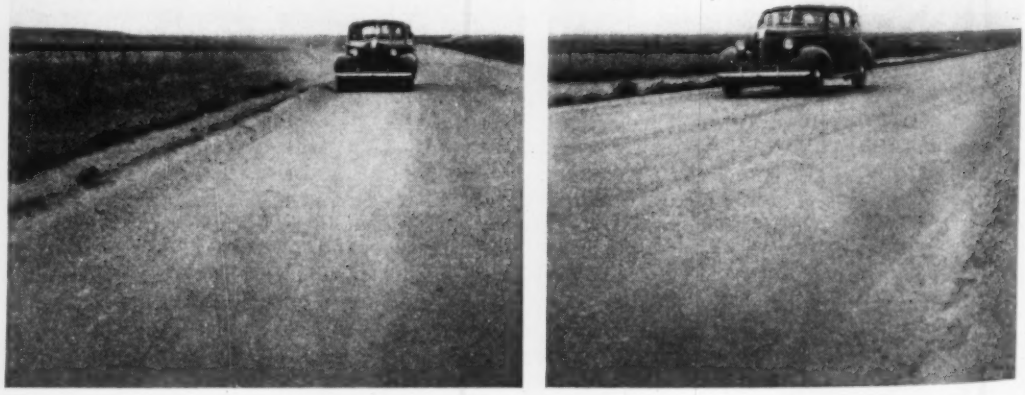
In 1929, when the legislature gave the Highway Commission direct control of all state highways, there was a demand from practically the entire state—communities and individuals—for a connected system that could be built with the revenues available and in the least possible time. The Commission met this demand by surfacing a large mileage of highway with sand, gravel, chats, or crushed stone and other local materials.

This work (the so-called "light-type" surfacing) involved the placing of approximately 600 cu yd of material per mile in a windrow, from which it was spread over the road as needed and worked into the surface by traffic. The cost was commensurate with the funds available, and the treatment provided a surface adequate for lighter traffic which met the current demands of the public. At least by comparison, this type of road work was so different, and to the citizens so constructive, that it met a very favorable reception. It has continued to be one of the most popular methods of obtaining a year-round surface. Within a short time the state had a large mileage, more or less connected, of this type of work.

With the large increase in traffic which developed in the state about that time, we found there were generally two things wrong with this type of road: (1) It was dusty, and therefore hazardous for driving; (2) it was apt to become corrugated and rough during protracted rainy periods. Concurrently some of the neighboring states were developing oil mats and penetration surfaces that eliminated both these difficulties, and Kansas, after some investigating, decided to try them out herself. Results were favorable, and within a few years the state had constructed a large mileage of such surfaces, varying in degree from a penetration application of perhaps $1/2$ in. in thickness to heavier mats involving about $3\,1/2$ in. of compacted material.

As we were behind most other parts of the country in road work, we found ourselves being more or less pushed into the development of some form of connected system. It may as well be admitted that during this period engineering principles, while not entirely forgotten, were at least shunted aside in the effort to provide the traveling public with a surface comparable to what it found in other states. Most of the engineering department staff realized that the type of construction adopted was used simply to meet a demand, and that maintenance costs must necessarily be high. It must also be admitted that our knowledge of soils during this early development period was negligible. Had there been some constructive information available, the cost of the work could have been considerably reduced, and a great deal accomplished in the way of providing heavier surfaces where needed.

We recognize today that, from an engineering standpoint, we have about completed that nucleus of "demand" roads and are at this time building with the idea of providing an adequate surface for traffic needs. An inventory of Kansas highways today shows a state system of nearly 10,000 miles, including 787 miles of earth, 3,060 miles of light surfacing, 4,117 miles of various types of oil, and 1,445 miles of high-type pavements.



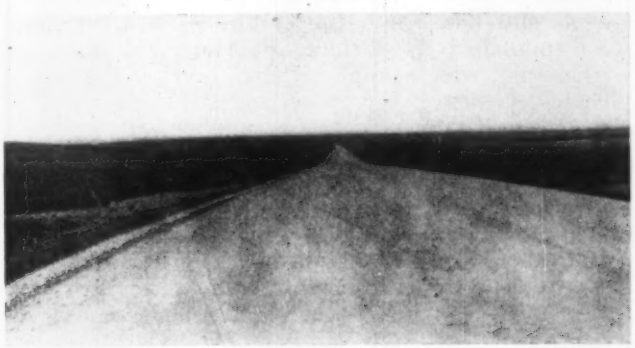
LOW-COST KANSAS ROADS
Left: A Stretch of Sand-Gravel; Right: A Penetration Surface

The state ranges between two extremes in a number of factors which affect road construction. The topography in the eastern part is rough and hilly, the terrain becoming generally rolling to undulating and then flat in the extreme west. Rainfall ranges from 42 in. per year in the southeast to as little as 16 in. in the extreme southwest.

The soils in the eastern half, which constitutes the area of higher rainfall, are largely residual clays derived from limestones and shales. The clays are highly plastic, exhibit high volume change upon change in moisture content, and become unstable when wet. Bedded limestone is exposed over much of this area. The fact that a major portion of these limestones are water-bearing presents a difficult problem in drainage which must be taken care of in any type of road construction.

The soils in the western portion are generally derived from loess and unconsolidated water-laid deposits. Generally these soils are sandy, well drained, and stable. The occurrence of soils of this nature in an area of low rainfall presents opportunities in road building far more pleasant than those encountered in eastern Kansas and ideally adapted to low-cost construction.

Traffic density ranges from as little as 100 vehicles per day on some roads in thinly populated areas, to as much as 8,500 in areas adjoining Kansas City and Wichita. While some of the growth of traffic has been anticipated and cared for, the development of industry has brought rapid increases in certain localities. The development of coal mining and oil production has not only increased the number of vehicles, but has also changed the picture materially in so far as type of transportation is concerned. Traffic studies have shown that in some oil-field developments, commercial vehicles constitute from 50 to 70% of the total number of units.



U.S. 77S NEAR FLORENCE, KANS., IS A STABILIZED BASE OF LOCAL CRUSHED STONE WITH BITUMINOUS SURFACE TREATMENT

COUNTIES FOLLOWING STATE LEADERSHIP

Today we feel that the development of low-cost roads on the state system, dovetailing as it seems to into stage construction, will show the way for improvement of a large mileage of county and township roads under the secondary system. In fact, some of our financially able counties are even now proving the accuracy of this statement. Today many counties have a well-connected system of light-type surfaced highways and are already graduating into dustless surfaces. We point to this with some pride, for we feel that a number of these county organizations in carrying on this program have had the benefit of watching the Highway Commission in its work.

In addition to providing a final surface on low-traffic roads, light-type surfacing has proved very beneficial as a stabilizer in the later development of roads of higher type. It also lends itself readily to use on detour development, and on new grading work that is not yet ready for the final surface. In fact, for the most part its use can be considered temporary, as public demand soon forces the next stage in road development—the dustless type.

BITUMINOUS MAT CONSTRUCTION WITH A TRAVELING PLANT

For permanent grades the use of 600 cu yd of aggregate per mile seems advisable. For narrow roadways and temporary work, 400 cu yd will meet general needs. For subgrade soils having plasticity indices from 6 to 15, a smaller amount will be adequate.

CONSTRUCTION OF PENETRATION SURFACES

In 1938 the state placed a penetration coat of bituminous material on approximately 600 miles of highways, mostly in the western two-fifths of the state. An inspection in March 1940, after winter conditions unparalleled in the history of the highway department, showed that practically all this mileage had come through the winter in satisfactory condition. Traffic in those localities varied from about 200 vehicles per day to as much as 750, with a probable average of about 450 vehicles per day.

The treatment consists of a light application of bituminous material (approximately $^1/_2$ gal per sq yd), placed directly on the surface of the existing roadway and followed by a $^1/_4$-gal seal coat, on which is added aggregate to provide a non-skid finish. The cost of this type of work in Kansas, with an oil price applied of approximately 6 cents per gal and an aggregate bid price averaging about $1.50 per cu yd, is around $1,100 per mile.

Bituminous penetration is especially useful for surfacing unsuitable locations where construction of the new route cannot be undertaken for several years, and for work on the heavier traveled detours. It has been most successful in the western part of the state, where the soils have low plasticity indices, low volume change, and remain stable through the changes in moisture content to which they are subjected. It cannot be used satisfactorily on the more plastic, expansive clay soils, which become unstable when wet.

Some preliminary studies of surface comparison in the western third of the state will be of interest. Using figures for cost of surface construction and maintenance for light-type surfacing, as compared with the same items for penetration work with a traffic of 250 vehicles per day, it was found that over a ten-year period the light oil application involved an additional expenditure of only about $50 per mile per year. This comparison, it should be noted, does not take into account either wind or erosion losses on the grade where light-type surfacing was used.

The state has built a large mileage of bituminous mats, from densely graded aggregates, with a thickness varying from $^3/_4$ to $3^1/_2$ in. Specifications have varied as various ideas came before the engineers. Most of these changes were made with the thought of correcting existing faults in the mats; however, we are convinced today that unsatisfactory subgrades, rather than the mats themselves, were the main source of grief. It is worth mentioning that in mat construction we found conclusively that oil content should be kept to a minimum, in order to obtain satisfactory compaction and to prevent slipping and corrugation.

The thinner mats create a difficult maintenance problem, since with the methods used in the field the oil content is difficult to control. Heavier mats approaching what today is known as a bituminous stabilized base, have produced much better riding surfaces and have been cheaper to maintain.

MIXING AND WETTING DOWN A SOIL-CEMENT STABILIZED BASE NEAR ST. JOHN, KANS.

BITUMINOUS MATS VS. PENETRATION SURFACES

For some time there has been a question in the minds of most of the men connected with the Highway Commission as to where this type of construction best fits into the Kansas highway picture. In some cases bituminous mat costing $3,500 per mile has been placed near penetration work involving $1,100 per mile, and the difference in the two roads has been so slight that we have had to look up the records to see which was which. This convinces us that soil type and subgrade condition are the major factors in the design of bituminous surfaces for light traffic. Penetration surfaces have been entirely successful in areas where desirable subgrade soils are found. However, where the soils are of inferior grading and of a more plastic nature—that is, where they are on the border-line between good and poor soils—mats have shown themselves superior to the light penetration surface type. It should be brought out, however, that even the thicker mats have not proved themselves successful in eastern Kansas on the heavier clay soils unless they have been placed on base courses of adequate thickness and strength.

We have felt for the past several years that the high-pressure period of road development in the state has about ended, and that it is time for the Highway Commission to start on a program of more permanent types of construction. High maintenance costs on the present type surfaces are taking a large toll from the available revenue, and better roads that will allow us to reduce this maintenance are needed. In line with this reasoning it is now our practice, on permanent location for medium-service surfacing, to go into stabilized base construction, providing a light armor coat of bituminous material to protect the base from wear in all areas where the natural subgrade soils are unsuitable, or where good soils for constructing the subgrade cannot be found and used economically.

LOCAL MATERIALS FOR STABILIZED BASES

Kansas has a variety of materials available for such work and has taken advantage of them wherever possible. Hard, durable limestone occurs in workable beds over the eastern third of the state. Included in this region is a glacial area in the northeast which supplies glacial gravels and sands, and the flint hills area, covering a strip approximately 30 miles wide and 150 miles long farther east, which supplies chert gravel in the form of hillside deposits of clay gravel and stream bar deposits. The extreme southeast corner is supplied with aggregates in the form of mine-run chats from lead and zinc mines in the tri-state district. Limey shales occur in the north central section. Soft limestones are available in the north and central western portions over large areas exposed by erosion. Mortar beds or caliche are available in scattered deposits over a large area in the southwest. In addition, sand-gravel occurs in hillside deposits in the western half of the state and in numerous stream beds.

Almost all these deposits, combined where necessary with soils and other materials, have been used for the construction of bases. These courses range from 4 to 12 in. in thickness, with a 6-in. thickness predominating. In all cases they have been covered with a protecting wear course of penetration asphalt or double armor coat. They are giving excellent results, and relatively few failures have developed.

Costs of bases have ranged from about $3,000 per mile, for natural local materials which have required no processing, to $10,000 per mile for bases constructed of combined aggregates which have required processing.

It has been found that specifications providing for the best use of local materials cannot be set up without a detailed field and laboratory study of the materials in the vicinity. Each project must be treated as a separate problem. For this reason, materials and soils surveys have been made an integral part of the plans survey, so that complete information is available to the designer when he starts his work.

To be of value such information must, of course, be properly applied to design. Realizing this, we have been carrying out a program of equipping our laboratory with adequate facilities and training our field and office personnel in the fundamentals of designing and constructing stabilized base courses. We feel that now, with the theory of stabilization using local materials, and the base course requirements of the various soils in different climatic conditions better understood, stabilization will become an important aid in constructing low- and medium-cost roads that will give good service.

Model Studies of Overflow Spillway Sections

Variation in Discharge Coefficient with Change in Upstream and Downstream Face Angles, and with Submergence, Investigated

By A. S. Offitzeroff

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Using a modified Creager profile for his spillway section, and varying the angle of the plane portion of both the upstream and the downstream face, the author has conducted two rather extensive series of experiments on discharge coefficients which are worthy of serious study. The first series is on unsubmerged spillways, and is directed toward analysis of the coefficient as a function of the face angles. The second series is concerned with the effect of submergence, and results in the principal conclusion that American data underrate the capacity of a submerged spillway up to about $D/H = 0.75$, and in most cases overrate it above that point.

THE literature of hydraulics records few investigations of the influence of upstream and downstream face angles on the discharge coefficient of an overflow spillway. Bazin's experiments with a weir of triangular section can scarcely be taken into account in this connection, for they concerned a sharp edge and did not exclude the effect of vacuum upon the coefficient. Similarly, the experiments of the late G. W. Rafter, M. Am. Soc. C.E., on the influence of the upstream face angle are of little value in estimating the discharge capacity of a modern spillway, since they were conducted on trapezoidal weirs with vertical downstream faces. Prof. Williamson, of Cornell University, more recently conducted similar experiments with a trapezoidal weir having a downstream face angle of 26° 32′ with the horizontal. This is somewhat closer to the profile of a modern spillway; nevertheless, the influence of sharp edges and of vacuum still prevailed.

The experiments reported in the present paper were conducted on models of purely practical spillways, with the curved portion corresponding in all cases to the coordinates given in Table I. These are Creager's coordinates (see *Hydroelectric Handbook*, by William P. Creager and Joel D. Justin, Members Am. Soc. C.E., John Wiley and Sons, 1927, p. 209) extended and adjusted by the writer, and tests and comparisons have convinced us that they result in the best among vacuumless sections. The purpose of the first set of experiments was to study m, the coefficient of discharge in the expression

$$Q = mL\sqrt{2g}\left(H + \frac{V^2}{2g}\right)^{3/2} \quad \ldots\ldots\ldots (1)$$

as a function of α_1 and α_2, the angles formed by the upstream and downstream faces of the spillway, respectively, with the horizontal.

The weir height, P, varied between 0.10 and 1.21 m, and the design head, H_d, between 0.05 and 0.40 m. The upstream face angle, α_1, varied from 90° (that is, a vertical face) to 15°, and the downstream face angle, α_2, from 56° 20′ to 10° (see spillway profile, Fig. 1).

The four principal model weirs consisted of wooden frames, covered with a wire net and then with a layer of cement mortar. The straight portions of the upstream and downstream faces were formed by removable plywood panels, terminating in sharp-edged metal plates that could be rested against and attached to the curved concrete section at the proper points to produce the desired face angles. The weir heights were varied by means of an auxiliary floor in the flume.

The first three models were tested in a hydraulic flume with a working portion 10 m long and 0.503 m wide. Discharges ranged up to 75 liters per sec, and were measured by means of Bazin's spillway, using a calibrated volumetric method. The large model (H_d = 0.40 m) was tested in an outdoor flume at the laboratory on the Institute for Scientific Research on Water Works, Sewerage and Engineering Hydrogeology, Moscow. This flume is 0.70 m wide, 2.0 m deep, and 70.0 m long. Discharges ranged up to 1.5 m³ per sec and were measured by means of Pitot tubes and with a temporary measuring spillway.

A catalog of the experiments performed on these models is presented as Table II. In addition to these, other experiments were carried out for α_2 = 56° 20′, and α_1 = 90°, with H_d varying between 0.089 and 0.214, and H_d/P between 0.125 and 0.675.

Table I. Coordinates of Spillway Section for Unit Head on Crest

x	y	x	y	x	y	x	y
0.0	0.126	0.7	0.100	1.4	0.564	2.1	1.369
0.1	0.036	0.8	0.146	1.5	0.661	2.2	1.508
0.2	0.007	0.9	0.198	1.6	0.764	2.3	1.653
0.3	0.000	1.0	0.256	1.7	0.873	2.4	1.804
0.4	0.006	1.1	0.321	1.8	0.987	2.5	1.960
0.5	0.027	1.2	0.394	1.9	1.108	2.6	2.122
0.6	0.060	1.3	0.475	2.0	1.235	2.7	2.289

Ten series of experiments were run with various upstream face angles, α_1, while the downstream face angle, α_2, remained constant and equal to 45°. The results are presented in two forms in Fig. 2: a series of curves of $m = f(H)$, with α_1 as the parameter, and a series of curves $m = f(\alpha_1)$, with H as the parameter. Either set of curves can of course be derived by taking sections through the other. It is to be noted that H is expressed in terms of the design head, H_d, and that the curves are thus independent of the value of H_d and of the height of weir, P.

The relation $m = f(\alpha_1)$ shows that the discharge cofficient decreases with α_1, and that the vertical upstream face (α_1 = 90°) gives the largest coefficient. The relation $m = f(H)$ shows the increase of the coefficient with H, even for heads equal to twice the design head.

By means of experiments with α_1 = 10°, 15°, 30°, 45°, 60°, and 90°, the relation $m = f(\alpha_2)$ was similarly obtained. It is

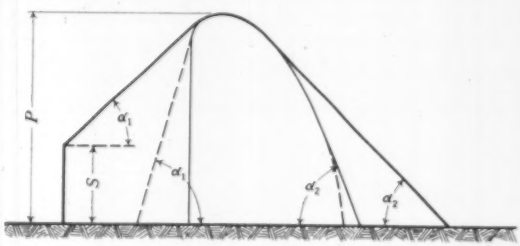

Fig. 1. The Spillway Profile

illustrated here (Fig. 3) for the case where $\alpha_1 = 90°$. The curves $m = f(H)$ are also given in Fig. 3. As was to be expected, the discharge coefficient decreases with α_2.

Referring to Figs. 2 and 3 and to analogous figures, it was possible to prepare Table III showing the relation $m = f(\alpha_1, \alpha_2)$. This table contains absolute values of the discharge coefficient for a spillway model with a section corresponding to the coordinates of Table I.

Obviously, the influence of the upstream and the downstream faces of the dam upon the discharge coefficients may be expressed as a relative value or as a relative coefficient, m_α. Thus if we select as a "standard" spillway the spillway with $\alpha_1 = 90°$, and $\alpha_2 = 60°$, the coefficient of influence of slopes will be, for it, $m_\alpha = 1$, while for most other combinations of slopes it will be less or more than unity. For example: Since for $\alpha_1 = 90°$ and $\alpha_2 = 60°$, $m = 0.499$, whereas for $\alpha_1 = 15°$ and $\alpha_2 = 15°$, $m = 0.441$ (according to Table II), the coefficient of influence of

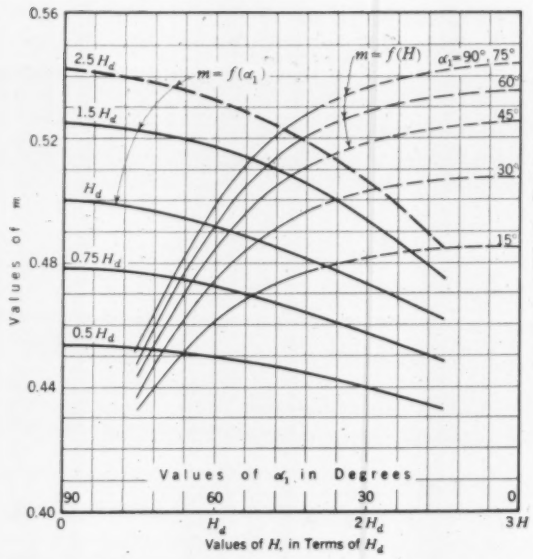

FIG. 2. VARIATION OF m WITH α_1 AND H, FOR $\alpha_2 = 45°$

TABLE II. CATALOG OF EXPERIMENTS WITH FOUR PRINCIPAL MODELS

P	L	H_d	α_1	α_2	Number of Experiments
0.60	0.503	0.05	90°, 60°, 45°, 30°, 15°	45°	72
0.40	0.503	0.05	90°, 60°, 45°, 30°, 15°	45°	80
0.20	0.503	0.05	90°, 60°, 45°, 30°, 15°	45°	87
0.60	0.503	0.10	90°, 75°, 60°, 45°, 30°, 15°	45°	79
0.40	0.503	0.10	90°, 75°, 60°, 45°, 30°, 15°	45°	77
0.20	0.503	0.10	90°, 75°, 60°, 45°, 30°, 15°	45°	72
0.10	0.503	0.10	90°	45°	14
0.72	0.503	0.15	90°, 60°, 45°, 15°	45°	64
0.52	0.503	0.15	90°, 45°, 30°, 15°	45°	55
0.30	0.503	0.15	90°, 60°, 45°, 30°, 15°	45°	78
0.58	0.503	0.10	90°	45°, 30°, 20°, 15°	44
0.58	0.503	0.10	30°	45°, 15°, 10°	46
0.58	0.503	0.10	15°	45°, 15°, 10°	41
0.58	0.503	0.10	45°	45°, 15°, 10°	44
0.58	0.503	0.10	60°	45°, 15°, 10°	43
1.21	0.767	0.40	90°	45°	10
1.21	0.767	0.40	15°	45°, 10°	17

slopes for the latter spillway will be $m_\alpha = 0.441/0.499 = 0.883$.

Determining the coefficient m_α in this manner it is easy to prepare a table for $m_\alpha = f(\alpha_1, \alpha_2)$ analogous to Table III, and from this table to draw graphical relations between the coefficient and the slope. Such a diagram is given in Fig. 4, based on a spillway with vertical upstream face ($\alpha_1 = 90°$) and a downstream slope of 3:2 ($\alpha_2 = 56° 20'$) as the standard. The diagram shows values of m_α for the design head only. It will be noted that the minimum value of m_α is 0.88 and the maximum is 1.006.

Introducing m_α, Eq. 1 becomes

$$Q = m_\alpha \cdot mL\sqrt{2g}\left(H + \frac{V_0^2}{2g}\right)^{3/2} \quad \ldots\ldots (2)$$

Evidently m_α, as determined from Fig. 4, may be applied to all kinds of spillways of modern practical shape, insignificant errors being neglected.

Since absolute values of a spillway discharge coefficient depend on the height of the model, on Reynolds' number, on submersion, and on a number of other factors, we believe it reasonable in spillway design to use not the absolute coefficient values from Table III, but relative ones from Fig. 4. However, the method of determining the coefficient m for the "standard" spillway, by which m_α is to be multiplied, is beyond the scope of the present article.

The remainder of this paper is concerned with experiments on the effect of submergence on the discharge of weirs. Previous work along this line includes that of the U.S. Deep Waterways Board, done in 1900, the results of which are still enjoying a merited success both in the United States and in Europe. It is to be noted, however, that the Board's experiments were conducted on a spillway of a now obsolete cross-section. The model was 1.5 m high, its crest was curved to a radius of about 1.0 m, its upstream face was vertical, and its downstream face formed an angle of 45° with the horizontal. The obsolescence of shape is evident from the fact that for the case of no submergence, m was found to be 0.462 (instead of 0.50, as in modern spillways) under conditions of a two-dimensional problem; and from the fact that, as a rule, such large radii of crest curvature are not used at present. Moreover, more recent data developed by Eisner and by N. N. Pavlovsky indicate that the American data considerably understate the submerged spillway capacity.

TABLE III. VALUES OF m FOR VARIOUS VALUES OF α_1 AND α_2, FOR $H = H_d$

Values of α_1	Values of α_2					
	90°	75°	60°	45°	30°	15°
90°	0.501	0.500	0.499	0.4965	0.4865	0.466
75°	0.500	0.499	0.4975	0.4955	0.485	0.465
60°	0.4955	0.495	0.494	0.492	0.482	0.4615
45°	0.4875	0.487	0.486	0.484	0.4755	0.456
30°	0.4775	0.4775	0.476	0.474	0.466	0.449
15°	0.463	0.463	0.463	0.4615	0.454	0.441

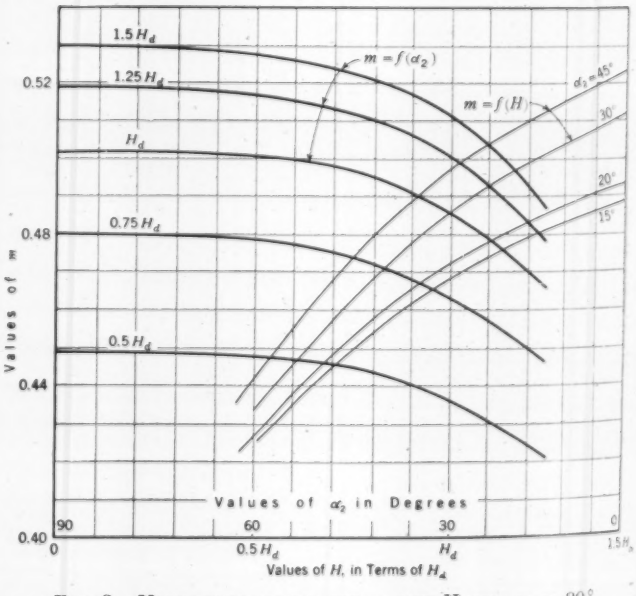

FIG. 3. VARIATION OF m WITH α_2 AND H, FOR $\alpha_1 = 90°$

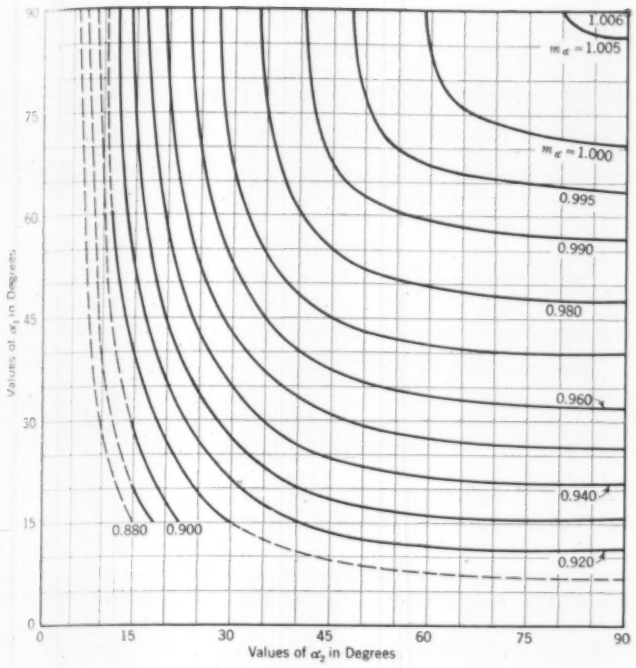

FIG. 4. COEFFICIENT OF INFLUENCE, m_α, OF FACE ANGLES
Values Shown Here Are Based on a "Standard" Section with $\alpha_1 = 90°$, $\alpha_2 = 56° 20'$, and Are Applicable to the Design Head Only

Hence, in spite of the extreme facility of determining the coefficient from the American data, the above considerations compelled the author to carry out a series of experiments with a submerged spillway of a "modern" cross-section. The shape used was that of Fig. 1, with the coordinates of the curved portion as given in Table I. For one model P was 0.35 m, and for the other 0.72 m, while L was 0.503 m, and the design head H_d was 0.15 m in both cases. The heads used during the experiments reached 0.185 m. The step S was absent and the upstream slope was rectilinear. The angle α_1 varied in the experiments from 15° to 90°, whereas α_2 was constant at 45°.

TABLE IV. EXPERIMENTS ON SUBMERGED WEIRS

Spillway Data				Number of Runs to Determine		$m_n = f(D/H)$ Plotted in
P	H_d	α_1	α_2	$Q = f(H)$	$Q_n = f(D)$	
0.72 m	0.15 m	90°	45°	15	41	Fig. 5(*a*)
0.72 m	0.15 m	60°	45°	15	23	Fig. 5(*b*)
0.72 m	0.15 m	45°	45°	15	27	Fig. 5(*c*)
0.72 m	0.15 m	30°	45°	15	25	....
0.72 m	0.15 m	15°	45°	15	19	....
0.35 m	0.15 m	45°	45°	15	42	....
0.35 m	0.15 m	30°	45°	15	41	....

The experimental procedure was as follows:

1. The characteristic $Q = f(H)$ was determined in the absence of submersion.
2. The characteristic $Q_n = f(D)$ was determined under the conditions of submersion on the downstream side, with different values of H. (D is the elevation of the downstream water level above the crest.)

TABLE VI. SUBMERGED SPILLWAYS: RECOMMENDED VALUES OF m_n FOR USE IN THE FORMULA $Q = m_n m \sqrt{2g}\, L(H + V^2/2g)^{3/2}$

m_n	D/H	m_n	D/H	m_n	D/H
1.000	0	0.988	0.35	0.933	0.70
0.999	0.05	0.983	0.40	0.68–0.91	0.75
0.998	0.10	0.978	0.45	0.63–0.89	0.80
0.997	0.15	0.972	0.50	0.54–0.86	0.85
0.996	0.20	0.965	0.55	0.44–0.73	0.90
0.994	0.25	0.957	0.60	0.28–0.53	0.95
0.991	0.30	0.947	0.65	0.00	1.00

3. From the first and second characteristics for the same values of H, the values of $m_n = Q_n/Q$ (that is, the degrees of reduction in capacity owing to submersion) were computed and plotted against the corresponding values of D/H.

(It is to be noted that in determining H and D the approach velocity was neglected.)

In accordance with this procedure, 323 "runs" were made. Table IV shows the range of conditions covered, and readers interested in the detailed data are referred to our *Spillway Hydraulics* (Energoïsdat, Moscow, 1938) for a complete tabulation of the observations. The relations $m_n = f(D/H)$ for three of the seven general cases studied are plotted in Fig. 5, together with the American data previously referred to.

The curves presented in this figure and in others not published show that:

1. The function $m_n = f(D/H)$ is independent of the value of the discharge over the spillway and of the head above the crest. This means that all points of the relation $m_n = f(D/H)$ for a given spillway give the same curve, independent of Q and H. In this respect our data fully coincide with the American data.
2. The function $m_n = f(D/H)$ is essentially influenced by the shape of the spillway, for values of D/H greater than 0.75. In this respect our experiments differ from those of the U.S. Deep Waterways Board, since in their work only one spillway cross section was tested, and hence only one curve was obtained.
3. In the function $m_n = f(D/H)$ the continuity is sometimes disturbed. Physically this breach of continuity signifies the transition of the downstream water jet from a condition where it follows the spillway contours to another condition under which it moves on the downstream water surface. The discontinuity is observed in the region of D/H values and is most prominent when α_1 is close to 90°. It disappears with α_1 approaching 15° to 30°.

TABLE V. VALUES OF $m_n = f(D/H)$

D/H	Model P = 0.72 m, H_d = 0.15 m; α_2 = 45°; and α_1 is as follows:					P = 0.35 m; H_d = 0.15 m, α_2 = 45°; α_1 is as follows:		According to American Data
	90°	60°	45°	30°	15°	45°	30°	
0.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.05	1.000	1.000	1.000	1.000	0.999	0.999	0.999	0.996
0.10	0.999	0.999	0.999	0.999	0.998	0.998	0.998	0.991
0.15	0.998	0.997	0.997	0.998	0.997	0.997	0.997	0.986
0.20	0.996	0.996	0.995	0.996	0.993	0.996	0.996	0.981
0.25	0.993	0.994	0.994	0.995	0.989	0.994	0.995	0.976
0.30	0.991	0.989	0.992	0.992	0.986	0.992	0.993	0.970
0.35	0.988	0.986	0.990	0.990	0.982	0.988	0.990	0.963
0.40	0.984	0.980	0.986	0.984	0.979	0.984	0.986	0.956
0.45	0.977	0.975	0.982	0.978	0.975	0.978	0.981	0.948
0.50	0.969	0.968	0.976	0.972	0.972	0.972	0.974	0.937
0.55	0.963	0.960	0.971	0.964	0.967	0.965	0.967	0.923
0.60	0.954	0.951	0.965	0.955	0.962	0.956	0.960	0.907
0.65	0.941	0.939	0.955	0.945	0.955	0.946	0.948	0.886
0.70	0.928	0.925	0.943	0.933	0.940	0.933	0.932	0.856
0.75	0.914–0.685	0.908–0.780	0.925	0.913	0.916	0.918–0.765	0.908	0.821
0.80	0.887–0.628	0.886–0.734	0.892	0.860	0.872	0.898–0.720	0.875	0.778
0.85	0.856–0.545	0.858–0.663	0.805	0.745	0.792	0.870–0.650	0.820	0.709
0.90	0.437	0.555	0.630	0.600	0.650	0.545	0.730	0.621
0.95	0.285	0.380	0.390	0.400	0.430	0.365	0.530	0.438
1.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

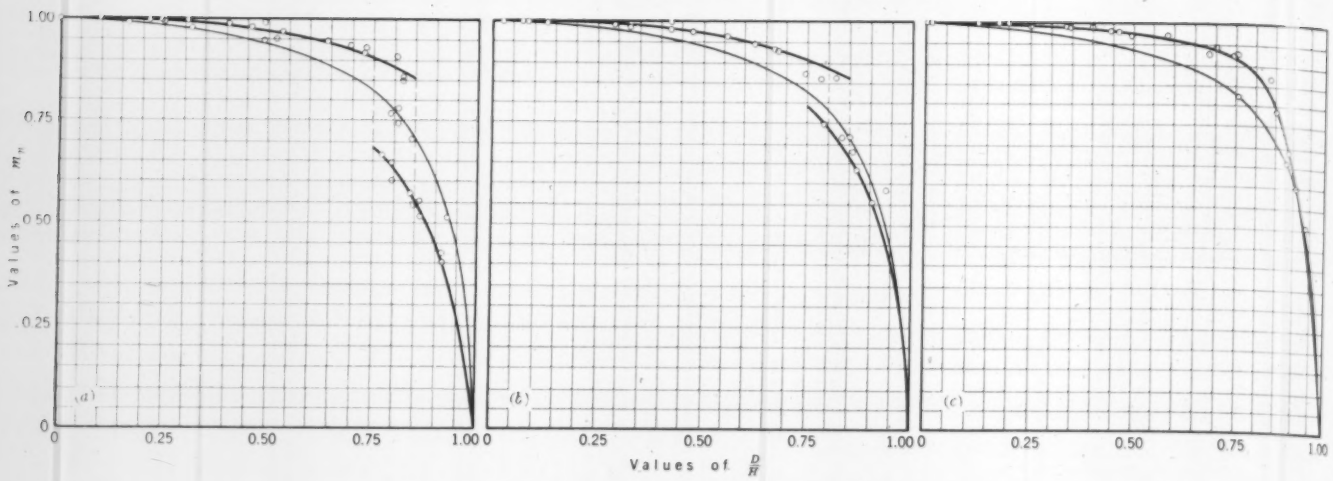

FIG. 5. TYPICAL m_n CURVES FOR SUBMERGED SPILLWAYS
All Spillways Similar Except for Upstream Face Angle, Which in (*a*) Is 90°, in (*b*) 60°, and in (*c*) 45°

4. The American experiments underrate the capacity of a submerged spillway over the whole range of values of D/H from 0 to 0.75, and in most cases overrate it in the interval between 0.75 and 1.0.

From Fig. 5 and other similar drawings we have prepared Table V, summarizing the relation between the coefficient of submersion and D/H. For the purpose of comparison, the American data are also given in this table.

This table may evidently be averaged and applied to any type of spillway of a modern practical shape. In this case the variations of the downstream face angle within practical ranges will not affect these conclusions. The results of averaging are given in Table VI, which is intended for use in computations. In the region $0.75 < D/H < 1.0$, linear interpolation may be used, the lower value of m_n corresponding to $\alpha_1 = 90°$, and the higher value to $\alpha_1 = 15°$.

ENGINEERS' NOTEBOOK

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

A Graphical Method for Land Subdivision Problems

By RAY KINSLOW
VICKSBURG, MISS.

MANY problems which arise in the subdivision of land can be shortened and simplified by using a graphical method of solution. The solution of three of the most common subdivision problems is outlined here, these being sufficient to illustrate the method.

Example No. 1: In Fig. 1, *ABCD* represents a traverse that has been plotted, and it is desired to cut off a certain area by a line perpendicular to *AD*. The usual method of solution is as follows: A trial line is drawn so that it cuts off approximately the required area. The actual area cut off is then computed, and the difference between this and the required area is found. This difference is a correction trapezoid to be added to or subtracted from the trial area. However, since there are two unknowns in the trapezoid (the altitude and one base), the computations become considerably involved, or a trial-and-error method must be resorted to, which will require the computation of several trial areas.

To solve this problem by the graphical method, the line *AY* is drawn perpendicular to *AD*, and the lines are used as ordinate and abscissa in plotting an area curve of the traverse. *BJ* is drawn perpendicular to *AD*. The area of triangle *ABJ* is computed, and the area is represented by *IJ*, which is plotted to any convenient scale. The remainder of the base is then divided into equal parts, *JL*, *LQ*, etc. These equal parts may be made any convenient length such as 5, 10, or 25 ft. The area of trapezoid *BMLJ* is next computed, and the sum of this area and that of the triangle *ABJ* is represented by *KL*. Since the distances *JL*, *LQ*, etc., are equal, each succeeding trapezoid will be increased in area by the amount equal to the area of one of the small shaded rectangles. No further computations are necessary as the curve can now be extended beyond this point by the use of a pair of dividers. After the curve has been extended beyond the point where it is estimated that the required line will fall, it may be stopped. The required area is then scaled along *AY*. Suppose that this is *AO*. Point *O* is then projected to point *G* on the curve, and then down to *AD*, giving *FE*, the required line. Once the curve is plotted the traverse can be subdivided further without additional computations. This is often done when subdividing a tract of land into lots. Suppose that the area *AR* is to be cut off. *R* is projected to *S* on the curve and the line *TU*, drawn through *S*, would cut off that area. When it is desired to know what area

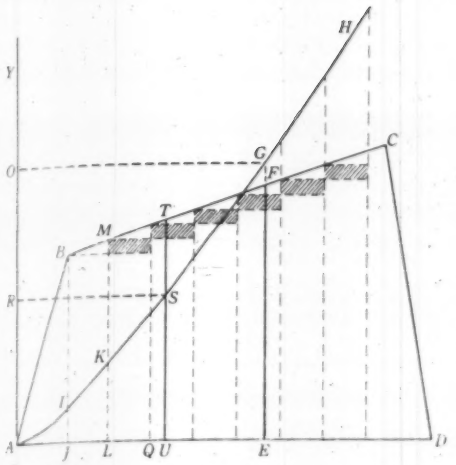

FIG. 1. CUTTING OFF A GIVEN AREA BY A LINE PERPENDICULAR TO *AD*

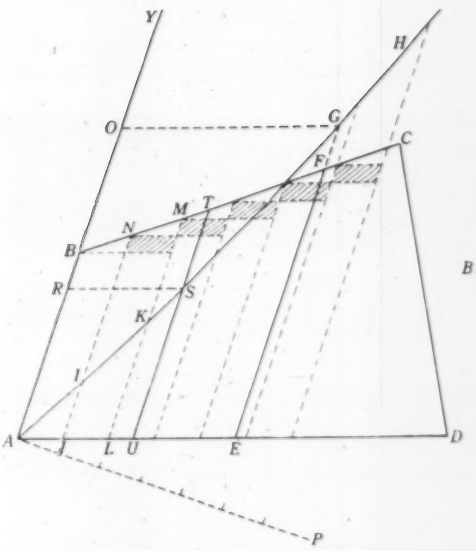

FIG. 2. CUTTING OFF A GIVEN AREA BY A LINE IN A GIVEN DIRECTION NOT PERPENDICULAR TO *AD*

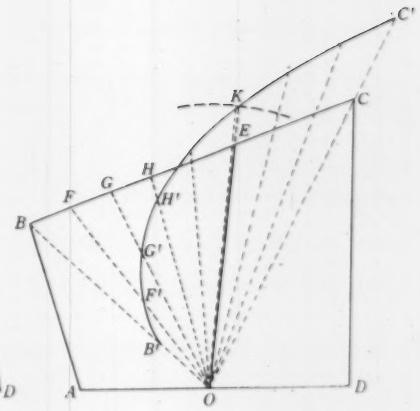

FIG. 3. CUTTING OFF A GIVEN AREA BY A LINE THROUGH A GIVEN POINT

is cut off by given lines, the curve may be used. The points where the given lines cut the curve are projected to *AY* and the area scaled.

Example No. 2: Suppose that the line is to extend in some direction other than perpendicular to *AD*, such as parallel to *AB*. Practically the same method is used as in the former example except that the coordinates are not rectangular, but *AY* is chosen along *AB* (see Fig. 2). Only the area of the first trapezoid and one of the shaded parallelograms is computed. It will be found convenient to construct *AP* perpendicular to *AB* and scale the altitudes of the trapezoids on this line. If the curve is nearly straight these distances need not be as small as if there is considerable curvature.

Example No. 3: Reference is made to Fig. 3. In this problem a given area is to be cut off by a straight line passing through a given point. Polar coordinates are used in this case. Suppose that the line is to pass through point *O*. The side of the traverse on which the other end of the line will fall can be estimated. Suppose that it will fall on *BC*. The area of triangle *ABO* is first computed and this area represented by *OB'*. *BF* is then laid off along *BC*, forming triangle *OBF*. The area of *OBF* is computed and *OF'* scaled to represent the area of *OABF*. If *FG*, *GH*, etc., are made equal to *BF*, no further computations will be necessary, since the areas of triangles *BOF*, *FOG*, *GOH*, etc., are equal. The other points on the curve are plotted so that *OG'* equals area *OABG*, *OH'* equals area *OABH*, etc. A radius is then taken equal to the required area, and with *O* as a center an arc is drawn cutting the curve at *K*. A line drawn from *O* to *K* determines the required line *OE*. Although this last example can be solved directly without the trial-and-error method, the actual computations required are less by the graphical method.

A Model Rigid Frame

By KENNETH W. DOWIE

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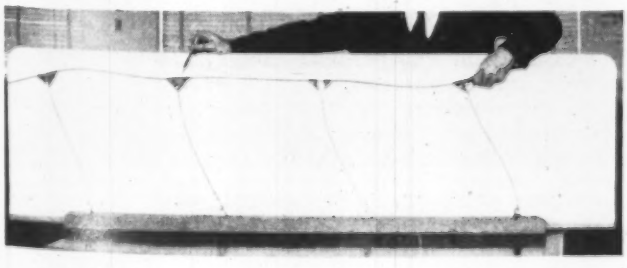
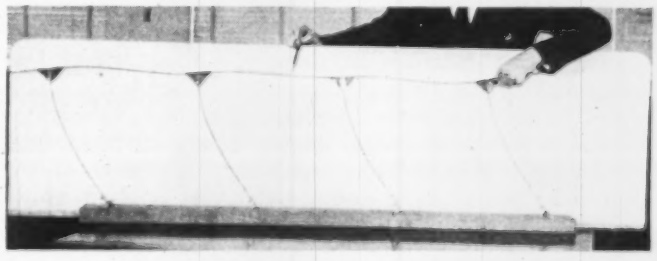
AS Hardy Cross states so emphatically, if one is unable to picture accurately the deformations of a frame under load, he is not in a position to make a correct analysis of the stresses.

With this in mind, the writer has constructed a model rigid frame of spring steel. The frame consists of three continuous spans of 19 in. and two 9-in. cantilevers, on four columns approximately 18 in. high, girders and columns being connected by small gusset plates. As these members are made of 12-gage spring steel, they respond very readily to light loads, and with their high elastic limit completely regain their original shape when the load is taken off. Columns are all removable, partly to make it easier to carry the frame around, but mainly



EFFECT OF A LONGITUDINAL LOAD ON THE FRAME, WITH END COLUMNS FIXED AND INTERMEDIATE COLUMNS FREE



LONGITUDINAL LOAD WITH ALL COLUMNS FREE AT THE BASES. PENCIL POINTS TO A POINT OF CONTRAFLEXURE

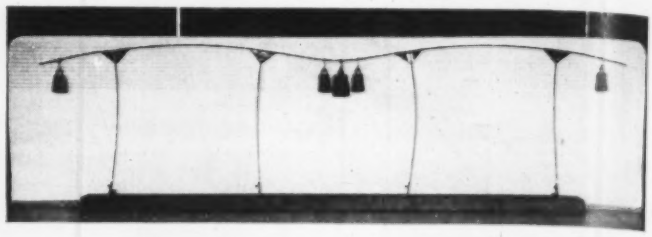
to investigate the effect of loading spans of unequal length.

The large load shown in one of the illustrations weighs 2 lb, the small loads 1 lb each. For horizontal loads, such as would exist in a bridge with earth-filled abutments, or from temperature, seismic or tractive forces, deformations are most clearly shown by applying such loads with the hands.

In order to show the difference in stress due to having fixed and free-end columns, a locking device has been arranged that enables the demonstrator to lock or free the base of each column at will. It was found necessary to anchor the column bases, as under unsymmetrical loading some columns developed negative reactions.

If it is desired to show the presence of these negative reactions in a somewhat dramatic fashion, it is a simple matter to loosen the thumb-screw anchors and apply a heavy live load, whereupon some of the columns pop out of the ground.

While it is in no sense a precision instrument such as the Beggs Deformeter or Gottschalk's Continostat, it is expected that this model will make a large contribution to the group teaching of rigid-frame analysis. It has already been used by a class of engineers led by Glenn Enke, Jun. Am. Soc. C.E., Associate Bridge Engineer of the Bridge Department, State of California. Many favorable comments have been received, and it is thought that by means of the model an instantaneous grasp of the deformations is possible, with a clear understanding of the proper loading to secure maximum moments in the various parts of the structure.



LOADS IN FIRST AND THIRD SPANS, ALL COLUMN BASES FREE
Horizontal Lines on the Background Are Half an Inch Apart

The ever-present question of side sway is often puzzling to the student. Perhaps it might as well be admitted that even old-timers have been known to get their signs mixed up. However, by placing the proper loads on the model frame, the problem of the correct direction of the bending moments is instantly clarified.

Conversion of Units and Dimensions

By C. J. POSEY, ASSOC. M. AM. SOC. C.E.
and J. W. HOWE, ASSOC. M. AM. SOC. C.E.

RESPECTIVELY ASSOCIATE PROFESSOR OF HYDRAULICS AND STRUCTURAL ENGINEERING, AND ASSOCIATE PROFESSOR OF MECHANICS AND HYDRAULICS, STATE UNIVERSITY OF IOWA, IOWA CITY, IOWA

EVERY undergraduate knows that Sir Isaac Newton first formulated an equation accurately representing the relation between the force acting upon a particle, its mass, and its acceleration. In courses in mechanics a good deal of attention is devoted to the ramifications encountered in applying this relationship to special cases of motion of particles and rigid bodies. Yet the average student would be stumped by the simplest problem if the units given were not those to which he was accustomed. Choose a more complicated relationship between less simple variables, involving perhaps a change from the "absolute" to the gravitational system of units, and even experienced engineers will hesitate, proceeding only with the utmost caution.

Though the necessity for giving more attention to the units of measurement should be evident, the problem has received little attention in engineering literature. The injunction that "the variables entering this equation must be measured in the units specified" is often repeated, but seldom is anything said about what to do when measurements in the specified units are not available. It is apparently assumed that the conversions necessary will be so simple that no study of the method of making conversions is necessary. In view of the difficulties often experienced, however, such a study seems decidedly worth while. In fact, critical study of the customary methods of making the simpler conversions reveals the reason for difficulty with the more complicated cases.

In this article the writers present a method that is simple and nearly fool-proof. While the method may seem strange, and contrary to ordinary usage, experience in teaching it over a period of years has shown that students quickly grasp the fundamental idea, and soon became proficient in making conversions of complicated units. It should not be inferred that need for careful thought has been eliminated. Demand on thought and energy has been minimized, but care is still necessary.

One frequently finds information on units printed as follows: 1 ft = 12 in. This is not an equation, for the numbers on each side do not balance, and neither do the units. One does not equal 12, and feet do not equal inches. The statement "one foot equals twelve inches," however, would be recognized as a statement of fact. Why is it that a statement which is correct when spoken is incorrect when written down? Study of the logic of the sentence shows it to be idiomatic. What we really mean to say is that the distance measured by 1 ft is equal to the distance measured by 12 in. Some would write: 1 ft $\equiv$ 12 in. This does not overcome the difficulty, for an identity has to conform to all the rules applying to an equation, and more. An identity must be an equation, but an equation need not be an identity. How, then, is the fact represented by the statement to be correctly set down in algebraic symbols? The writers use the following form, which may seem clumsy when applied to this simple case, but which will be shown to possess advantages in clarifying the computations for more complicated cases.

$$1 \text{ ft} \times \frac{12 \text{ in.}}{1 \text{ ft}} = 12 \text{ in.}$$

This is an equation, for it evidently balances, both with respect to the numbers and the units. Moreover, it may be converted into a general formula.

$$X \text{ ft} \times 12 \frac{\text{in.}}{\text{ft}} = Y \text{ in.}$$

The conversion factor 12 $\frac{\text{in.}}{\text{ft}}$ has units as well as numerical value. Recently published handbooks are beginning to recognize this fact when they tabulate conversion ratios with the column and row headings giving definite instructions to "multiply the number of feet by 12 to get the number of inches." Of course, in so familiar a case, definite instructions are not necessary. Everyone knows that there will be a larger number of inches than feet in a given distance. Definite instructions are necessary, however, when the units are not familiar.

Suppose it is necessary to convert an acceleration of 5 miles per hour per sec into centimeters per sec per sec. The conversion is made in steps, as follows:

$$5\,\frac{\text{miles}}{\text{hour sec}} \times \frac{1}{3{,}600}\,\frac{\text{hour}}{\text{sec}} \times \frac{5{,}280}{1}\,\frac{\text{ft}}{\text{mile}} \times \frac{30.48}{1}\,\frac{\text{cm}}{\text{ft}} = 224\,\frac{\text{cm}}{\text{sec}^2}$$

Another example:

$$6.3\,\frac{\text{acre-ft}}{\text{hour}} \times \frac{43{,}560}{1}\,\frac{\text{ft}^2}{\text{acre}} \times \frac{1}{3{,}600}\,\frac{\text{hour}}{\text{sec}} = 76.2\,\frac{\text{ft}^3}{\text{sec}}$$

For frequent use, the conversion constants may be combined,

$$6.3\,\frac{\text{acre-ft}}{\text{hour}} \times 12.1\,\frac{\frac{\text{acre-ft}}{\text{hour}}}{\frac{\text{cu ft}}{\text{sec}}} = 76.2\,\frac{\text{cu ft}}{\text{sec}}$$

The procedure may be summarized as follows: first write down the measurement to be converted, including its units. Then find what ratios of units (of the same dimension) the given quantity has to be multiplied by to give the desired units. After inserting the correct numerical values of these ratios, or conversion factors, the arithmetical part of the conversion may be completed.

Units should not be confused with dimensions. There may be units when there are no dimensions. For example,

$$60\,\text{deg} \times \frac{\pi}{180}\,\frac{\text{radians}}{\text{deg}} = 1.047\,\text{radians}$$

Length, time, and force are the fundamental dimensions of the gravitational system. These quantities may be measured in feet, seconds, and pounds (English units) or in meters, seconds, and kilograms (metric units). In converting dimensions in the gravitational system to the corresponding dimensions in the absolute system, the conversion factors are not constants, for they will vary with the local value of the acceleration of gravity. Suppose it is required to convert 1.4 in.-lb (English units, gravitational system) to dyne-centimeters (metric units, absolute system).

$$1.4\,\text{in.-lb} \times 2.54\,\frac{\text{cm}}{\text{in.}} \times 445{,}000\,\frac{\text{dynes}}{\text{lb}} = 1{,}580{,}000\ \text{dyne–centimeters}$$

The factor 445,000 $\frac{\text{dynes}}{\text{lb}}$ is correct where the local value of the acceleration of gravity is 32.2 ft per sec per sec. A common example of this type of conversion is the change from poises to the corresponding English gravitational units. A poise is one dyne-sec per sq cm, so that to convert, say, 1.5 poises,

$$1.5\,\frac{\text{dyne sec}}{\text{cm}^2} \times \frac{1}{445{,}000}\,\frac{\text{lb}}{\text{dyne}} \times \frac{(30.5)^2\,\text{cm}^2}{\text{ft}^2} = 0.00313\,\frac{\text{lb sec}}{\text{ft}^2}$$

The examples given should make it evident that the work of converting units can be reduced to a simple and logical system if we are willing to completely abandon the traditional method of writing "equations" that are not equations. The newer handbooks, such as Eshbach's *Handbook of Engineering Fundamentals*, have made a step in this direction (in the tables of Section 1). If the method presented in this article is used, the tabulations of factors can be made much shorter.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Photoelastic Analysis of Stress in Earth Masses

TO THE EDITOR: Messrs. Farquharson and Hennes presented an interesting and valuable paper in the April issue. I fully agree that photoelastic models can be most helpful to the engineer in estimating the stresses in earth masses. Gelatin models have been used rather extensively in the last few years for this purpose. It must be recognized, though, that these models have their limitations and that the result should not be applied without full knowledge of the photoelastic properties of the gelatin and of the fundamentals of the theory of elasticity. The stress distribution in any gelatin model is very seldom correct throughout.

Gelatin models were used at Fort Peck to check certain specific applications of the theory of elasticity and to determine the effect of different types of material in the embankment section using triangular shaped loads.

Some comment on the results of the experiments run at Fort Peck using different materials in the model embankments may be of interest. It is not often that we find materials in nature which have the basic characteristics assumed in the elastic theory. In practically all cases where the foundation material is a source of weakness, the embankment is constructed of entirely different material; therefore, the embankment and foundation cannot correctly be considered as a homogeneous mass. In these experiments gelatin, corn meal, and modeling clay were used in the embankment.

Gelatin Embankment. Gelatin approaches the perfect material, which is homogeneous, elastic, and isotropic, and for that reason the stress distribution checks fairly close to the computed values by the elastic theory method. Deformation of the gelatin because of its low strength gives an unreliable stress distribution where this deformation occurs. Slumping of the top of the model and bulging at the toes cause the lines of equal stress to be distorted at these points. The most reliable stress distribution in the gelatin model is in the center of the model and along the rigid boundary where a minimum amount of deformation occurs.

Corn Meal Embankment. A model of similar dimensions was made with the embankment composed of corn meal and the foundation of gelatin. The pattern of the equal pressure line is similar to the gelatin model, except at the toe of the embankment where this model shows very little distortion of the lines of equal stress. The maximum shearing stress above the rigid boundary is the same as for the homogeneous gelatin model, but the stresses along the rigid boundary are less.

Modeling Clay Embankment. Another model of similar dimensions was made with the embankment composed of relatively stiff

modeling clay. The shearing stress pattern in this case is distinctly different from that produced by either the gelatin or the corn meal loading. The modulus of elasticity of the modeling clay was so much greater than the gelatin foundation that it acted as a rigid mass. The stress pattern is therefore similar to a rigid uniform strip loading.

A summary of all the results of the model tests conducted shows that none of the model results check exactly the theoretical shearing stress distribution. Gelatin gives the closest approximation, because it more nearly fulfils the requirements of the theory of elasticity that the mass must be homogeneous, elastic, and isotropic.

It is my belief that an analysis based on the theory of elasticity contains an inherent factor of safety, inasmuch as no natural soil is truly elastic and plastic deformation is present to reduce the intensity of the maximum stresses computed by the elastic methods.

The Ohio River Division of the U.S. Engineer Department has recently made a study of the stability of the I-type flood wall by a full-scale test in the field and has checked the wall in the laboratory using gelatin in a photoelastic model. The model tests checked the field tests very closely.

T. A. MIDDLEBROOKS, Assoc. M. Am. Soc. C.E.
Washington, D.C.

Honoring the Civil Engineer

DEAR SIR: In Colonel Wilgus' article, "Commemorating the Civil Engineer," in the May issue, he says: "the Society might well institute measures to bring about the attachment of the name of the engineer to the products of his imagination, as is ever done with that of the architect, author, sculptor, musician, and painter."

In case this idea is adopted, I suggest that the full name of the engineer be given instead of the surname alone. For instance, there may be some uncertainty even today as to whether Lake Mead was named for the late Elwood Mead or Daniel W. Mead, both of them eminent in hydraulics.

Also, some people believe that the Holland Tunnel was named for a European country and not for the engineer who was so closely identified with its construction. Some years hence there may be some doubt as to which Roosevelt was honored in the Roosevelt Dam.

It is the custom in Argentina, and perhaps in other countries, to use the full name in such a connection.

PHILIP W. HENRY, M. Am. Soc. C.E.
Consulting Engineer
New York, N.Y.

Extraction of the Square Root

TO THE EDITOR: I wish to suggest a slight correction to the brief article, "Simplified Extraction of the Square Root," by Antonio Di Lorenzo, in the May issue. It is stated that, "If a square root is obtained to any number of significant figures, the correct answer can be expanded to about three more significant figures by merely dividing half of the remainder in the operation at that point by the approximate answer." Actually, instead of giving three more significant figures, the process described approximately doubles the number of significant figures.

There is a modification of this technique, which I have found very convenient with a computing machine. Given a number N and its approximate square root R, on the machine compute $Q = N/R$. Then the next approximation is $R' = {}^1/_2(R + Q)$, valid to about twice as many digits as are common to R and Q. Proof:

Let: $R = R' + {}^1/_2 x$; $Q = R' - {}^1/_2 x$; $N = (R' + y)^2$

Then: $N = RQ = R'^2 - {}^1/_4 x^2$; $N = R'^2 + 2R'y + y^2$

Equating, and neglecting y^2 by comparison with $R'y$, $-{}^1/_4 x^2 = 2R'y$; $y = -x^2/8R'$. Then if, for example, R and Q agree to five digits, x/R' is of the order of $(0.00001)R'$, and y is of the order of $(0.00001)x$ (the factor 8 serving as a margin of safety in the use of "orders of magnitude"), or $10^{-10}R'$.

H. H. HOWE
U.S. Coast and Geodetic Survey
Washington, D.C.

Calculating Cross-Sectional Areas

TO THE EDITOR: In connection with Mr. Potts' article, in the March issue, on the use of the coordinate method of calculating cross-sectional areas, a further expansion of this method as applied to highways and superelevation may be of interest to some of the younger engineers.

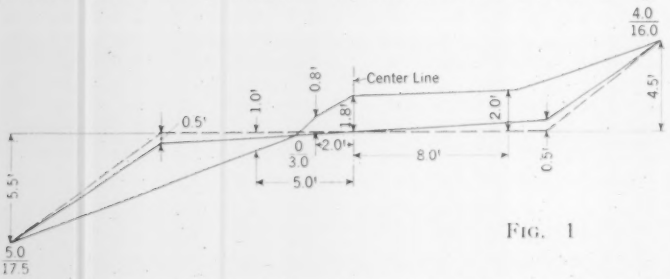


FIG. 1

The accompanying Fig. 1 is the cross section of a highway in cut and fill on a curve with a superelevation of 1 ft, and roadbed width of 20 ft, with $1^1/_2$:1 slopes.

These areas may be computed in the cross-section book by writing cross-section notes to the horizontal line as in Fig. 2. Then the computations will be:

Fill				Cut					
− 0.5	− 5.5	− 1.0	−0.15	− 1.5	+0.8	+ 1.8	+ 2.0	+4.5	+ 0.5
−17.5	+ 5.0	+14.5	+5.0	− 2.0	+3.0	+10.0	+16.0	+2.0	−16.0
+ 8.75	−27.50	−14.50	−0.75	+3.00	+2.40	+18.00	+32.00	9.00	− 8.00

+ 8.75	+ 3.00
−27.50	+ 2.40
−14.50	+18.00
− .75	+32.00
	+ 9.00
	− 8.00
−34.00 ÷ 2 = 17.00 fill area	+56.40 ÷ 2 = 28.20 cut area

In writing the notes in the cross-section book so they can be computed and the computations retained in the book for reference, the instrumentman should first record the C. L. as 0/0 and then superelevation each side of the center line and one-half the roadbed

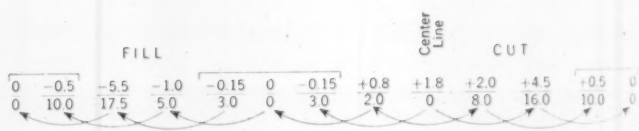


FIG. 2

width with the proper sign for the superelevation, using (−) when below the horizontal and (+) when above the horizontal as shown under the end brackets in Fig. 2. Then the $\frac{0/0}{X}$ cut-and-fill point on the superelevated roadbed should be found and recorded in its relative position on the page as shown under the center bracket in Fig. 2, writing 0/0, with the superelevation for the point and the distance out to the point on each side of 0/0.

In recording the balance of the notes the cuts to the horizontal line should be used with the proper distance out, which would require correcting for recording the markings on the slope stakes by the amount of the superelevation.

Computations are made by subtracting the inner recorded distances from the outer recorded distances and multiplying the result, by the intermediate recorded cut or fill, paying particular attention to signs in order to keep the plus quantities separated from the minus quantities. In crossing the center line the distances out should be added together for the multiplier. These steps are shown by the arrows.

This method may have the appearance of being complicated, but actually an instrumentman can learn how to record the notes almost as quickly as the explanation can be written.

PAUL A. JONES, M. Am. Soc. C.E.
Construction Engineer,
U.S. Bureau of Reclamation
Glendive, Mont.

Bridges Over Navigable Channels

TO THE EDITOR: I read with much interest Admiral Whitman's article in the June issue, especially his reference to bridges over navigable channels.

In connection with the Golden Gate Bridge at San Francisco, it may be of interest to state that the permit issued by the U.S. War Department for this bridge while conditional was looked upon as being as valid as the regular permit issued. As it is the policy of the War Department to make no decision of approval or disapproval of a bridge project until formal application is made and public hearings are held following the enactment of the necessary legislation by Congress and/or the legislature authorizing the construction of the bridge, this of course is the usual procedure.

However, in 1924, a contrary precedent was established by Secretary of War John W. Weeks in recording advance approval for the Golden Gate Bridge before that project was authorized by legislation.

The apparent reason for this was that since this bridge connects two military reservations, there was a military question involved which prevented its being handled in the ordinary manner, and in 1927 final action was taken by the Chief of Engineers and the Secretary of War only, as would have been the case if the question of the interests of navigation alone had been the only one to consider.

THEODORE BELZNER, Affiliate Am. Soc. C.E.

Brooklyn, N.Y.

Engineering a Venerable Profession

TO THE EDITOR: In Colonel Wilgus' article, "Commemorating the Civil Engineer," in the May number, he remarks, "But the civil engineer has had a comparatively brief past from which to fire his imagination. His profession did not come into being as such until the invention of the Watt steam engine, 170 years ago, gave birth in Great Britain to private and public works on a vastly increasing scale."

Perhaps it is a matter of definition as to what constitutes a profession, but to my mind this statement is far from doing justice to engineers. This is especially true in view of the well-known historical facts and prehistoric remains that show the antiquity of civil engineering. In my article, "Tracing the Engineer in Early Egypt and Assyria" (CIVIL ENGINEERING for April 1931), I called attention to many of these engineering achievements, which are truly marvelous even when compared with our own great engineering feats of today. Since then many articles have appeared in CIVIL ENGINEERING and in other publications attesting to the antiquity of various engineering works.

Aqueducts, bridges, canals, dams, quays, lighthouses, tunnels, temples, palaces, pyramids, walls, obelisks, gigantic statues, roads, and water supply, irrigation, and drainage systems, were all works of antiquity. Details, such as wire rope, lead pipe, and lead bearing plates to evenly distribute pressure, and terra cotta pipe were used from 2,000 to 4,000 years ago. In fact, the beginnings of all such early civil engineering works are shrouded in the same haze that clouds the dawn of history.

In view of all this, I would prefer to emphasize the venerableness of our profession. In this way I believe we shall enhance our status. How else can we expect the public to have a higher regard for our calling?

JOSEPH HARRINGTON GANDOLFO, M. Am. Soc. C.E.

Montclair, N.J.

Transport Coordination Essential to National Defense Plan

TO THE EDITOR: Transportation is the most important element in military operations. Military success depends upon efficient transport, by land, on water, and in the air. This has been the lesson taught in the present European conflict, and our country must profit by it and insist upon the most efficient transport system in its defense plan.

The railroads are the most important factor in mass transport by land. The present railroad system may in peace times function with reasonable success, but in a national emergency, such as war would entail, it would be as deficient as other arms of our military strength. A strong defense plan calls for the immediate coordination of the railroads into an efficient mechanized unit, under centralized control to meet any possible emergency. The taking over of the railroads by the government after the declaration of war, as was done in the World War, would be a fatal mistake and would result in the same sad experience of extravagance, inefficiency, and failure encountered during that period. In the interests of our national defense, there must be immediate, prompt, and decisive action to prevent a like mistake now.

The national defense plan should include a national railroad coordination under a supreme authority of competent men. The country should be divided into five regions, under regional boards responsible to the national transport authority. Each of these regions should have its mileage of railroads divided into five separate systems, making a total of twenty-five operating units for the country as a whole. At present the railroads are composed of over 140 Class I roads with distinct and conflicting interests. About one-third of the country's mileage is and has been in bankruptcy for the past nine years. Another one-third is in near bankruptcy, so that nearly two-thirds of the mileage cannot function as would be required in a national emergency. This situation should not be permitted to continue, and those responsible for the "sit down strike," whether bondholders, stockholders, politicians, or labor, must compromise their differences, and reorganize these railroads promptly so that they may be placed in proper physical condition to meet the national need.

The first step in a national railroad coordination plan should be an inventory or survey of the entire railroad plant, by individual roads, to determine their capacity, physical characteristics and condition, requirements as to rehabilitation, expansion, or abandonment, and their financial needs so that they may fit into a coordinated whole to function efficiently in time of emergency. The public must not allow itself to be lulled into complacency in the belief that the present railroad plant is capable of meeting any demand made upon it in time of emergency, as seems to be the opinion of some. Complacency has resulted in bitter experience in the present European conflict, and we cannot afford to allow it to happen here.

The second step in a railroad coordination plan is to set up a complete plan of organization and operation of the railroads for national defense, and this should be done before and not after the emergency arises, as was the case in the World War. Production may be speeded up, but its capacity to produce will be measured by the efficiency of its most important ally, transportation. Transportation on the National Defense Commission, appointed by the President, calls for a full-time job, the same as in the case of procurement and production of materials.

L. C. FRITCH, M. Am. Soc. C.E.

Pasadena, Calif.

Further Comments on a Proposed Curriculum

TO THE EDITOR: I note that Mr. Hastings' proposed curriculum, outlined in the May issue, advocates commencing the study of mathematics with the calculus. It is my belief that few of our secondary schools offer sufficient training in mathematics to enable their graduates to enter an engineering school equipped to begin the study of calculus with profit in the first year of the engineering course. Not infrequently, freshmen entering an engineering school are not even sufficiently prepared in their elementary mathematics to begin the study of college algebra and trigonometry. The latter situation is taken care of at Purdue University by requiring such freshmen to pursue a "refresher" course in elementary mathematics before taking up the study of the regular freshman mathematics course.

The curriculum presented by Mr. Hastings appears to offer more or less of a general course in the elements of all branches of engineering for the first three years, leaving the fourth year to specialization in the civil engineering subjects. The writer believes that the present method employed in most of our engineering schools of inserting short courses in the fundamentals of other branches of engineering into a curriculum presenting a thorough training in civil engineering constitutes a more efficient use of the four years devoted to the study of civil engineering. An attempt to turn out a more or less composite engineer should be avoided.

It is noted that a course in surveying is offered for but one semester in the proposed curriculum. In my opinion so short a course would not give the student sufficient training in surveying. Since the average civil engineering graduate is usually called upon to perform surveying duties during his first few years out of school, and is expected to be reasonably proficient in performing these duties, it is rather essential that training in surveying be more thorough than can be acquired in one semester. A large number of engineering schools now require the attendance of civil engineering students at a summer surveying camp. At these camps, where a student may attain at least the semblance of the experienced surveyor, not only is he given instruction in field work, but by the performance of field duties, such as would be met in actual practice, he becomes adept at handling engineering instruments and solving field problems.

While the writer does concur with Mr. Hastings in the matter of cultural subjects and feels that the recent trend toward "sweetening" the engineering course with an overabundance of such subjects is unwise, he does believe that provision should be made in the freshman year for a sound training in the fundamentals of English grammar and for training in effective writing and public speaking because of the well-known weakness of even practicing engineers in the application of these subjects. The writer is entirely out of sympathy, however, with the attempt of some educators to offer a combined arts and engineering course. There is entirely too much ground to be covered in the engineering curriculum to permit such practice.

I think that provision should have been made in the proposed curriculum for railroad engineering, highway engineering, and geology. The first two named are rather basic subjects for the civil engineering student. The recent trend of work into which civil engineers are entering makes a knowledge of geology almost imperative.

In short, it is felt that too much dependence cannot be placed upon secondary schools for preparing students in elementary mathematics. A civil engineering course should include some training in other fields of engineering, but an attempt to train a student almost equally well in all branches should be avoided. Training in those subjects that a civil engineering graduate will be making use of in his first few years of practice should be stressed. While the inclusion of some cultural subjects may be desirable, an attempt to infuse an arts course into the engineering curriculum should not be made.

STANLEY B. DE HART, Assoc. M. Am. Soc. C.E.
Inspector, U.S. Engineer Office
West Springfield, Mass.

Biblical Justification for the Integrity of Surveyors' Points

TO THE EDITOR: What cadastral, topographic, geodetic, city, or county engineer has not at times cursed because some person or thing moved his section corner, boundary monument, geodetic point, or bench mark? Imagine the writer's high potential when he learned that his meticulously and expensively placed triangulation stations had been destroyed by Panama natives for their junk value!

For such supercharged engineers, perhaps with inhibitions against free and fully descriptive condemnations, there are ample precedents and justifications going clear back to the Mosaic Laws. Listen to the calm and judicious words of the inspired writers below (as called to my attention by Hiram E. Bryan, assistant city engineer, Rochester, N.Y.):

"Thou shalt not remove thy neighbors' landmark which they of old time hath set. . . . " (Deut., 19:14.)

"Cursed be he that removeth his neighbor's landmark. And all the people shall say Amen." (Deut., 27:17.)

Similar criticisms appear twice in the book of Proverbs and once in the book of Job. The same ideas have been transferred directly into the ritual of the Church of England. In its commination—where God's anger and judgments against sinners are proclaimed—for use on the first day of Lent, appear the words: "Cursed is he that removeth his neighbor's landmark." The congregation's response to this is "Amen."

Fundamentalist Scotland, during the days of the early Church with its unity of Church and State, took these Biblical injunctions in earnest; ways and means were provided for doing something about it. On or about June 25 the Bishop and a retinue of civil and ecclesiastical officials solemnly rode horseback over his diocese on a boundary inspection called Riding of the Bounds.

Such inspections were long ago abandoned. Nevertheless on this date in the city of Dumfries (Bobby Burns' town in both life and death) one sees a colorful street pageant also called the Riding of the Bounds. Local dignitaries head the procession on horses, followed by floats and walking representations of dozens of Scotland's best-known historical characters and events.

RALPH Z. KIRKPATRICK
Rochester, N.Y. *Civil Engineer, Panama Canal (Retired)*

Problems of Engineering Research

TO THE EDITOR: The comments on engineering research by M. G. Spangler, in the July issue, are very interesting and provide much material to think about. In addition to defining research it would have been helpful if Professor Spangler had recalled to mind the fact that engineering is "the science of controlling the forces, and utilizing the materials of nature for the benefit of man, and the art of organizing and directing human activities in connection therewith." This should narrow, to some extent, the twilight zone in which "purposeless bungling" and "persistent, intelligent groping" look alike. Another distressing feature of bungling is that it occasionally yields remarkable results. The percentage against winning is the same as in any form of gambling.

Professor Spangler discussed research in a rather broad sense, apparently with the long-time goal of major evolutionary changes in mind. Most men engaged in research are soon confronted with the realization that marked progress should be demonstrated within a reasonable length of time on whatever small portion of a major problem they have been asked (or have chosen) to work upon. A moderate knowledge of almost any type of investigational work on the part of the administrator will provide the ability to detect "purposeless bungling" in such circumstances. The path of active progress in research should be marked early with (1) a review of related literature, (2) a comprehensive and critical written discussion of the various phases of the problem, (3) a choice of those phases most likely to yield early results of value, and (4) the definite beginning of work on at least one of the more promising phases.

These early steps are essential for the purpose of sensing the proper direction and should not consume an unusual amount of time. It is difficult for the writer to place this time at more than six months or less than three, providing the problem is within the field of the worker's experience. The final steps will include the usual following of non-productive leads and backtracking until the proper path is found. Although such time cannot be estimated, definite progress can be discerned within a year if persistent, intelligent groping is used on the work. In experimental investigations, much time can be saved by a careful choice of variables and the use of a maximum spread in their values, consistent with available laboratory facilities. This procedure generally will reveal major controlling relationships.

I am cognizant of the fact that many outstanding investigaters are not meticulous in following each of the steps described above, in so far as outward appearances are concerned. Such men have a grasp of their field which renders such a procedure, particularly in the early stages, a distasteful and unnecessary task. These men are readily known by the quality, quantity, and scope of their published material. It is safe to assume that their early work was backed by painstaking effort in all phases, whether subjected to the scrutiny of a superior or not. The marked difference between an "inventor" and a man engaged in engineering research should be recognized, of course.

With regard to engineering research in educational institutions, care must be taken to avoid the common pitfalls that lead to the advocation of special interests, or to commercial testing. It is not always easy to do this in a project sponsored by industrial interests. Responsibilities in this connection may prove to be unduly heavy, if the limits of the work and the disposition of the results are not clearly understood by all concerned at the outset.

GEORGE C. ERNST, Assoc. M. Am. Soc. C.E.
Assistant Professor of Civil Engineering,
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Information Needed on Painting Steel Surfaces

TO THE EDITOR: I have read with much interest the symposium entitled, "Preparing Structural Steel Surfaces for Painting," which appeared in the July issue. The authors have carefully covered the ground and have left little to be added except practical experience in the same field.

Mr. Needles correctly states, that "the proper and thorough cleaning of steel in advance of the first shop painting is one of the most important steps in the entire painting procedure." It is absurd to expect any paint to preserve steel to which it is applied unless the mill scale, rust, dirt, and grease have first been removed. This also applies equally, or with even greater force, to the repainting of all structures which have been neglected, and upon which rust and corrosion have advanced so far that it is impossible to secure good preservation by ordinary methods of cleaning.

My experience with the sandblast cleaning of steel was gained during the earlier construction of the New York rapid transit subway. Without going into the details of this work, I will comment briefly on the results obtained. Owing to the magnitude of the project, the steel had to be ordered largely in advance from the manufacturer. Large quantities were received, and lay from eighteen months to two years piled high in the streets and in the yard at the foot of 42d Street at the East River. The steel was exposed to the elements for that period, and when the subcontractors were ready to use it they found that the paint had worn off considerably, and that a part of the steel was corroded. The work was started by hand cleaning—that is, by hammer, scraper, and wire brush. This did not prove satisfactory either in point of cost or in efficiency, and involved the subcontractors in an almost continuous controversy with the inspectors. However, it was suggested that the sandblast process be used, because of the fact that the subcontractors had compressed air pipes along the line of their work, thus facilitating the installation of such a process.

Approximately 5,000 tons of steel, consisting principally of bulb-angle-columns, I-beams for wall columns, roof I-beams, grillage beams, and plate girders, were cleaned by this process. Even though the cost of the sandblasting did not result in any direct economy over hand-cleaning, the results obtained were infinitely superior. The part cleaned had the appearance of frosted silver—in fact, it was fit to go into an electroplating bath.

If the mill scale, dirt, and grease were removed before the steel was painted, the protective coating given it at the shop would undoubtedly prove more effective in the prevention of corrosion than some of the present methods.

Most engineers are in great need of authoritative information on the subject of steel painting, aside from the conflicting data and exploded theories advanced by some paint manufacturers, and cannot afford either the time or expense to investigate it individually. Consequently there is room for a thorough discussion of the subject.

THEODORE BELZNER, Affiliate, Am. Soc. C.E.
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Time of Concentration of Small Watersheds

DEAR SIR: The article by Z. P. Kirpich on "Time of Concentration of Small Agricultural Watersheds," in the June issue, treats of a subject that has a fundamental place in the science of hydrology. Qualitative correlation between topographic features of a basin and concentration characteristics of the stream flow has long been recognized, and several investigations have been made to give this seeming correlation quantitative expression.

C. E. Ramser, in his 1927 report referred to by Mr. Kirpich, uses "time of concentration" as the measure of the basin channel characteristics. Present practice tends toward use of the unit hydrograph or the lag interval between center of mass of effective rainfall and the time of crest discharge or the center of mass of the associated direct runoff for this purpose. These measures are in a sense comparable and differ principally in their methods of derivation and flexibility of application. One difficulty the writer has encountered is that correlations between topographic factors and runoff characteristics that seem to work well with a given locality are not successful when applied to a different locality. It seems possible that the basins in a given locality are characterized by features associated with the topography which may be the more likely basis of the relationship. Although the lengths, slopes, and channel and basin shapes are variable, they may vary among the given basins according to a given pattern, such as the basins of greater length tending to be those of lesser slope. Thus, in the data furnished by Mr. Kirpich, a relationship can be shown to exist between length of the several basins and slope, the greater lengths apparently being associated with lesser slopes (Fig. 1). The existence of such a relation would seem to vitiate conclusions as to the general influence of a slope factor in Mr. Kirpich's analysis. In Fig. 2 a good relation is shown to exist between time of concentration and length of a basin. The velocity of travel according to this relation is about 4 ft per sec.

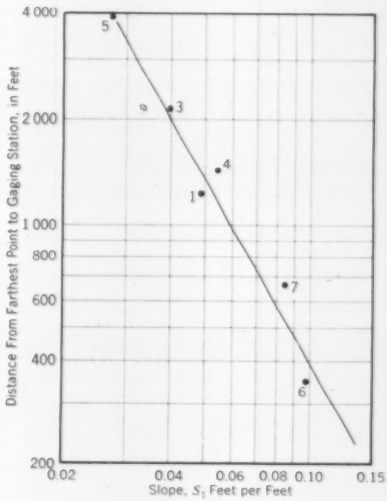

FIG. 1. RELATION BETWEEN MEAN SLOPE OF CHANNEL AND LENGTH OF CHANNEL

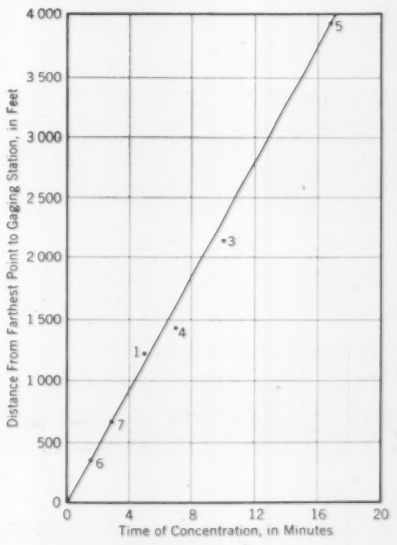

FIG. 2. RELATION BETWEEN LENGTH OF CHANNEL AND TIME OF CONCENTRATION

It would seem that the original data on which Mr. Kirpich's relationships are based may not cover a range of conditions sufficient to justify the application of the results to basins outside the limited Tennessee group, in which the slope, length, and possibly other factors may be interrelated in some way characteristic of that region.

W. B. LANGBEIN, Assoc. M. Am. Soc. C.E.
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SOCIETY AFFAIRS

Official and Semi-Official

Society Participates Officially in National Defense Program

In April of this year John P. Hogan, as President of the Society, was called to Washington for consultation in connection with the organization of all the industries of the United States for what is now known as "National Defense," and on May 6 he was commissioned chairman of the Construction Advisory Committee to the Army and Navy Munitions Board.

This committee, composed of the heads of six national organizations interested especially in construction, or their designees, includes as its other members Alonzo J. Hammond, M. Am. Soc. C.E., president of American Engineering Council; Stephen F. Voorhees, M. Am. Soc. C.E., past-president, American Institute of Architects (designated by the president of the Institute); Edward F. Palmer, M. Am. Soc. C.E., past-president, Associated General Contractors of America (designated by the Association); Malcolm Pirnie, M. Am. Soc. C.E., president of the Construction League of the United States; and Edward J. Harding, managing director of the Associated General Contractors of America. President Hogan and others of his committee have been to Washington in their official capacity a number of times since their appointment.

The Construction Advisory Committee has been in consultation frequently with the Munitions Board as to many matters affecting construction procedures, both for industry expansion and for government-owned projects, form of contracts, and method of payment thereunder, and has advised as to the necessary legislation to make these contracts operative and to permit of their prompt execution. Construction contracts on a fixed-fee basis are now in effect in both the Army and Navy. The Advisory Committee is still using its best efforts to separate engineering and architectural contracts from construction contracts. In this it has the wholehearted support of the Associated General Contractors of America. The Committee is also trying to induce acceptance of the idea that there should be no competition in fee but that the fee should be fixed and awards based on merit.

Whenever the question of men or firms available for assignment has arisen, the Committee has scrupulously avoided any recommendations of specific persons or firms. One exception has been that, at the request of the Constructing Quartermaster General and the Assistant Executive of the Army and Navy Munitions Board, the Construction Advisory Committee submitted the names of 8 men from whom there might be organized a Selection Board of from 3 to 5 members to recommend the award of engineering, architectural, or construction contracts. These names were those of a prominent business executive, engineers, an architect, and a contractor, resident in different parts of the country and all of whom have had wide experience in administration in the construction field.

Progress of the Census for Construction Preparedness

Since recounting the details of the Census for Construction Preparedness, in the July issue of Civil Engineering, a new element has been added. At the request of the Quartermaster General, listings of men capable of supervising construction and possibly available to be commissioned as Captains and Majors in the Quartermaster Corps have been made and submitted daily to Washington.

This was accomplished by inquiry of the Local Sections, which were asked to telegraph the names and addresses of men between the ages of 30 and 45, deemed suitable for this work and presumably desirous of accepting commissions as outlined. Again no limits have been drawn as to Society membership. The response was prompt and by July 15 the names of 423 men, submitted by 31 Local Sections, had been forwarded to the Quartermaster General. He in turn, presumably after some selective process, has forwarded application blanks direct to the individuals concerned.

As for the original elements of the census—determination of the total national professional abilities for the design and supervision of construction—to July 15, fifty-five of the 61 Local Sections in the United States had forwarded lists of firms or individuals. Three visits to Washington have been made by the Secretary or the Assistant Secretary of the Society, proffering the results of the census to responsible governmental agencies, and at the request of the Quartermaster General copies of 1,041 returned questionnaires of firms or individuals in private practice have been placed in his hands, supplemented by indications of their major technical specialties and cross referenced as to secondary specialties. It is understood these are to be photoprinted there and are then to be made available to the Civil Engineer Corps of the Navy and later to other federal bureaus or agencies desiring them.

Inquiry has been received from the newly established "Roster of Scientific and Specialized Personnel" for the names of all members of the engineering profession, and lists of those who have enrolled themselves in the 12 Technical Divisions of the Society have been furnished. How much further the proposed listing in the roster will go has not been decided, but offer of full cooperation by the Society has been extended.

With the exception of one instance, no selection or recommendation has been made of specific engineering firms with special qualifications. Rather, such selections have been left entirely to the governmental agency involved. In the exception referred to, a member of the Society especially qualified in the particular field of inquiry and not himself available, acted as "expert" in making selection of 10 firms capable, as indicated by replies to the questionnaires, of rendering the required performance.

The census is being treated entirely objectively and solely as a source of information; and when selections are requested in future a group of members of the Society will be assembled to act as experts as in the instance previously cited.

The work attendant upon the census has required the deferring of certain regular work and the engagement of three temporary employees, as well as the concentrated attention of two of the engineer members of the regular staff.

Arizona Report Adopted

Highway Commission Approves Grade Specifications and Salary Ranges

On June 28, 1940, the Arizona State Highway Commission adopted the classifications and pay scales recommended on March 29 by Society representatives, and instructed the State Highway Engineer to put them into effect at once. Only one minor change was made in the recommendations and that was to raise the pay range for the lowest sub-professional grade. The story of the original report appeared in the May 1940 issue of Civil Engineering.

This action of the Commission should be a source of great satisfaction to those who believe that a national engineering society can be of specific help to its members and to other engineers. Essential elements were that the Local Section analyzed the situation clearly and acted with commendable self-control; that the Commission welcomed the survey; that a recognized leader in the profession, in whom Arizona engineers had confidence, took an immediate and active interest; that the Highway Department cooperated fully and frankly; that the survey and report were made with complete objectivity; that the Commission received the report sympathetically and gave it careful study; that the Section followed up the presentation with strong resolutions and with wide publicity; and that the Section officers were aggressive in keeping the subject alive until action was taken by the Commission. It is believed that every one of these elements was necessary to bring the matter to its present successful conclusion.

Great credit is due to President Vic H. Housholder of the Arizona Section who displayed qualities of true leadership. When the salary reductions first came to the attention of the Section, Mr.

Housholder recognized the seriousness of the situation, put Section officers and members to work on assembling data, appeared before the Commission with former Director Raymond A. Hill and others, presided at several tense meetings of the Arizona Section, and later cooperated in the making of the survey. After the report was rendered on March 29, Mr. Housholder followed it up by further appearances before the Commission and before Governor R. T. Jones. Without question, his unselfish and continuous efforts, and the consistent cooperation of former Director Hill, played a large part in helping the Commission to its decision.

The remaining steps to make the plan effective have thus been placed in the hands of the State Highway Engineer, W. R. Hutchins, Assoc. M. Am. Soc. C.E., who is to carry out the instructions of the Commission and assign the engineering members of his staff to grade classifications and to pay steps within the salary ranges for those grades.

Central Illinois Section Performs Public Service

AN OPPORTUNITY to be of assistance to local authorities was recently offered to the Central Illinois Section. It came about in connection with the interest of the Section in obtaining a suitable man for an important civic engineering position. When informed of the engineering vacancy, the Section, with other local organizations, decided to investigate the circumstances, with the purpose of maintaining a high standard of practice.

During the course of the resulting deliberations, the city authorities made formal request for suggestions of five civil engineers who would qualify, any of them, for the appointment. The Central Illinois Section and the Illinois Society of Engineers, to whom jointly the request originally came, invited other local engineering societies to cooperate, some of which accepted. In due course, five names were supplied; and, what is more important, one of the suggested men was appointed.

This was very gratifying from a number of angles. To quote from the report of President C. M. Hathaway of the Section, "a very unpleasant situation" was terminated by a solution "which reflected credit upon the engineering societies and upon the engineering profession, not only due to the fact that we were called upon as engineers to perform this task but also due to the publicity through the press whereby the public well knew that the city officials had deemed it logical to ask an association of engineers to submit names of men qualified to handle a position of this character."

In proportion as Local Sections can creditably handle such situations, they will increasingly obtain the good will of the public. In time, it is to be hoped, as both confidence and knowledge increase, it will become recognized practice to depend on the Society's local groups for dependable recommendations.

District 7 Convention Announced

DISTRICT 7—comprising Michigan, Wisconsin, Minnesota, the Dakotas, eastern Montana, and adjacent parts of Canada—announces that its third annual convention will take place in Milwaukee, Thursday to Saturday, August 22 to 24. Following the plan of preceding years, there will be no technical papers on the program. Instead, the formal sessions will be given over entirely to discussion of Society affairs. Also on the schedule are a golf session, dinners, and entertainments on Thursday and Friday evenings, and a number of inspection trips on Saturday morning. Special social events for the ladies are of course to be included.

Headquarters of the meeting is the Hotel Pfister. Louis J. Larson is chairman of the committee in charge.

Annual Convention Under Way

AS CIVIL ENGINEERING goes to press, the Seventieth Annual Convention of the Society is convening in Denver, with members from all parts of the country in attendance. Next month's issue will carry a complete account of Convention events, and succeeding issues will feature a wide variety of papers from the Technical Division sessions.

University of Washington Students Set Two Fine Records

APPLICATION for Junior membership in the Society has been submitted by every one of the 30 graduates in civil engineering in this year's class at the University of Washington. Moreover, according to a recent report from C. M. Howard, president of the Seattle Section, the three additional students who are to receive degrees at the end of the summer quarter have also completed their applications. Congratulations are in order for the Student Chapter, its advisers, and other Society members whose contacts with the students have contributed to their interest in this first step in professional advancement.

Mention may well be made here also of the personal record set by Jack Ralph Benjamin, a member of the graduating class in civil engineering, who received the President's Medal for having the best grades of any senior in the university. A perfect "A" record for five years of undergraduate work was marred only by one hour of "B," which, a newspaper account says, he received in a shop course "because he couldn't make a good screw driver." Mr. Benjamin, an officer of the Student Chapter, holds a Tau Beta Pi fellowship for 1940–1941, and will take his graduate work in structural engineering at M.I.T.

Freeman Scholarship to H. G. Dewey, Jr.

SELECTION of Haywood Guion Dewey, Jr., Jun. Am. Soc. C.E., as recipient of the 1940 Freeman Traveling Scholarship in Hydraulics, was approved by the Board of Direction at its meeting in Denver on July 22. This is the first such award to be made for study in the hydraulic laboratories of the United States.

Since January 1936 Mr. Dewey has been with the hydraulic research laboratory of the U.S. Bureau of Reclamation, in Denver, his present rating being that of assistant engineer. He is a 1935 graduate of Cornell University, and received the degree of master of science from the University of Colorado in 1939.

The Freeman Fund was established in 1924 by the late John R. Freeman, Past-President and Honorary Member, Am. Soc. C.E., and its income is largely used "in the aid and encouragement of young engineers, especially in research work." The first traveling scholarships for the study of hydraulic laboratory practice were awarded by the Society in 1927, and up to the selection of Mr. Dewey, twelve such awards had been made.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies in 40 States

ENGINEERS AID DEFENSE

THROUGH its professional organizations and individually, engineers in large numbers have hastened to assure the government that they are willing and anxious to do everything within their power to facilitate the program of national defense. A few of the many offers made are:

American Engineering Council, through its president, Alonzo J Hammond, offered all its facilities to the command of the authorities. A White House reply indicated that at the present stage no specific task can be assigned to Council, but that its offer may be accepted in the future.

The American Society of Civil Engineers is sending a questionnaire to all known engineering firms and offices in the United States designed to furnish a ready list of the experience and capacities of engineers, designers, surveyors, and other specialists available for assignment to work connected with the national defense. Cooperating in this endeavor are the American Institute of Architects, American Institute of Mining and Metallurgical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, American Institute of Consulting Engineers, American Society of Heating and Ventilating Engineers, Society of American Military Engineers, American

Society of Refrigerating Engineers, and National Society of Professional Engineers. [See CIVIL ENGINEERING for July, pp. 464–465.—Ed.]

The American Society of Mechanical Engineers has adopted a three-point program that includes the offer to the government of the services of a special committee of experts on production problems; the addition of 12 leaders of industry to its national defense committee; and a general pledge of any other aid that may be requested.

The Society of Automotive Engineers, through its council, has set up a special committee to deal with national defense problems.

The American Society of Agricultural Engineers officially directed its executive council to offer its cooperation with any federal agency concerned with defense problems.

The Illuminating Engineering Society council authorized President Lester H. Graves to proffer its services in any way desired by the government.

The American Institute of Electrical Engineers at its Swampscott meeting took no official action, but sentiment was clear that the organization is willing and eager to cooperate.

The Western Society of Engineers, in a letter by President L. R. Mapes, offered its full cooperation.

The American Society for Metals took similar action in a telegram signed by President James P. Gill.

Individually, many engineers are already actively engaged in promoting the defense program. Among these are A.E.C. president, Alonzo J. Hammond, member of a special advisory committee on construction; executive secretary Frederick M. Feiker, appointed to a committee to review inventions in the field of defense, and many other engineers in similar positions.

BOARD TO COORDINATE PUBLIC WORKS PLANS

President Roosevelt has directed federal agencies engaged in construction activities to submit their plans for the future to the National Resources Planning Board, which will assemble them into a continuing plan looking six years into the future in order to indicate desirable priorities and avert conflicts among agencies engaged in different types of work.

The Board will maintain a review staff to work in collaboration with the Director of the Budget in the preparation of federal programs affecting land (including reclamation, land purchases, forests, and parks); water (including flood control, power development, pollution); transportation (public roads, navigation improvements); and other undertakings involving federal construction activities. It is expected to submit statements of plans and policies for transmission to Congress each year in connection with the annual budget that will permit the adjustment of federal work to help stabilize trends in employment and business activity. To fulfill this duty it will also be necessary for the Board to assemble reports of its own staff, and of other federal agencies, reflecting such trends in economic conditions.

Three new assistant directors have been appointed to the Board: Thomas C. Blaisdell, an economist who has previously served the NRA, the Resettlement Administration, the Social Security Board, and the Securities and Exchange Commission; Ralph J. Watkins, recently an assistant administrator of the Wages and Hours Division; and Frank W. Herring, for the last five years executive director of the American Public Works Association.

RATES BASED ON NET COST SET FOR HYDRO PLANT

Acting on its first rate case involving a licensed hydroelectric development, the Federal Power Commission has ordered the Safe Harbor Water Power Corporation, of Pennsylvania, to reduce its wholesale power rates so as to provide a net return of not more than 6% on the net investment in its properties, plus adequate working capital, thus upsetting the traditional "fair value" rate base that gives weight, among other things, to estimated reproduction cost. The decision was supported by four of the five commissioners, with the lone dissenter differing, not in principle, but in the belief that a return of only $5^1/_2$ per cent should be permitted on the net investment.

In announcing its decision the Commission points out that the old rate-making principle has been time-consuming, burdensome, and subject to economic shocks. The net investment base, on the other hand, is founded upon established facts "and is not subject to the vagaries of theories, imagination, and abrupt fluctuations of prices and conditions."

The Safe Harbor Company is a wholly-owned subsidiary of the Consolidated Gas, Electric Light, and Power Company of Baltimore, Md., and the Pennsylvania Water and Power Company, which purchase its entire output.

PWA STARTS LIQUIDATION

After seven years of operation in the financing and supervision of construction projects in all parts of the country, the Public Works Administration is now engaged in winding up its affairs under the Congressional mandate that it be completely liquidated by July 1, 1941. Personnel, which reached a peak of 10,400 persons when the last (1938) program was in full swing, is now down to 2,331, including over 500 engineers, and further reductions are being made rapidly.

The 1938 fund was limited to projects which could be "substantially completed" by July 1, 1940, and records indicate that 5,760 of the 6,156 approved projects are already completed and in use. Most of the remainder will be finished by the end of the current construction season, and only a few unusually difficult undertakings, such as the Chicago subway and the Pennsylvania toll highway, will require further supervision.

COMMITTEE TO CONSIDER ENGINEERING ETHICS

Preparation of a "Code of Ethics" for the engineering profession to form the basis for actions by member societies of American Engineering Council in adapting it to their specific requirements has been entrusted by President Alonzo J. Hammond to a newly formed committee headed by Dugald C. Jackson, professor emeritus of Massachusetts Institute of Technology, who will represent the American Institute of Electrical Engineers and the American Institute of Consulting Engineers. Other members are: Dr. William H. Kenerson, chairman, division of engineering, Brown University, representing the American Society of Mechanical Engineers; Arthur W. Dean, chief engineer (retired) Massachusetts State Planning Board, for the American Society of Civil Engineers; Dean J. W. Barker, Columbia University, Society for the Promotion of Engineering Education. Dr. Scott Turner will also participate as an observer representing the American Institute of Mining and Metallurgical Engineers.

Washington, D.C.
July 9, 1940

News of Local Sections

Scheduled Meetings

GEORGIA SECTION—Inspection trip at Tallulah Falls, Ga., on August 10.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday; dinner meeting of the Junior Forum at Hart's Restaurant on August 10, at 6:30 p.m.

SAN FRANCISCO SECTION—Dinner meeting at the Engineers Club of San Francisco on August 20, at 5:30 p.m.

SPOKANE SECTION—Luncheon meeting at the Davenport Hotel on August 9, at 12 noon.

Recent Activities

BUFFALO SECTION—*May 21:* Following a luncheon Charles Bullock, president of the Lakeside Laboratories and consulting engineer, spoke on "The Phenomena of Fluorescent Materials." Dr. Bullock illustrated his lecture with charts and the display of fluorescent minerals under an ultra-violet ray.

COLORADO SECTION—*Denver, June 11:* A dinner preceded the presentation of reports on the status of arrangements for the Annual Convention to be held in Denver. After the chairmen of the various committees had spoken, an old-fashioned dance was enjoyed. *Junior Association, Denver, April 26:* A colored film on the Denver water supply system was presented by H. L. Potts, water rights engineer of the Denver Water Board.

DULUTH SECTION—*May 20:* The speaker of the occasion was Col. X. H. Price, Corps of Engineers, U.S. Army, who described the present work of the U.S. Engineer Office at Duluth in administering the design and construction of improvements in the Lake Superior District.

INDIANA SECTION—*Indianapolis, June 7:* Several members of the committee on arrangements for the Fall Meeting of the Society

to be held in Cincinnati, discussed plans for the event, and H. S. Morse, chairman of the Section's Committee on Professional Objectives, made his report for that committee. The technical program that followed consisted of the showing of motion pictures depicting the work of the Ohio River Pollution Survey. E. S. Tisdale, sanitary engineer for the Survey, presented the film and discussed the history and accomplishments of the Survey.

KANSAS CITY SECTION—*June 6:* Following a dinner, letters were read from President Hogan, Secretary Seabury, and several other visitors to the Spring Meeting of the Society congratulating the Section on the success of the occasion. The technical speaker was J. R. Lloyd, senior meteorologist for the U.S. Weather Bureau, who discussed the subject, "Development and Progress in Modern Weather Forecasts." Lantern slides and plates were used to show movements of air causing rain, cold, and other weather phenomena.

OKLAHOMA SECTION—*Tulsa, May 20:* Members of the Section participated in Engineers' Day, a feature of the International Petroleum Exposition, held at Tulsa that week. At noon there was a luncheon, at which the Section was represented at the speakers' table by its secretary-treasurer, C. E. Bardsley.

PHILADELPHIA SECTION—*June 11:* The annual outing took place at the Sandy Run Country Club under the chairmanship of Paul MacMurray. The meeting got under way in the early afternoon, with some of the members taking advantage of the facilities for golfing. Later quoits and soft ball were in evidence. Following dinner, which was served in the club house, the election of officers for the coming year was announced as follows: Harry M. Freeburn, president; Julius Adler, vice-president; and E. L. Shoemaker, secretary-treasurer. Prizes were presented to the winners of the various sports events, and the members of the Section were then treated to an excellent display of magic presented by their fellow member, H. Lloyd Nelson. President Freeburn made a few remarks, outlining the objectives of the Section for the coming year, and Howard H. Demmert concluded the meeting with the showing of some colored motion pictures.

PITTSBURGH SECTION: C. B. Stanton has been elected to the Board of Directors of the Section, and Wilfred Bauknight succeeds him as secretary-treasurer. In the July issue it was incorrectly stated that Professor Stanton would continue as secretary-treasurer.

SACRAMENTO SECTION—*June 4, 11, 18, and 25:* At these regular weekly luncheon meetings the speakers were Ronald L. Campbell, planning engineer and secretary to the Planning Commission of San Mateo County; B. M. Woods, professor of mechanical engineering at the University of California; Donald R. Warren, consulting structural engineer of Los Angeles; and Ralph Tudor, principal bridge engineer of the California State Highway Department. *Junior Forum, June 12:* Phil Dickenson, of the U.S. Bureau of Reclamation, gave an illustrated talk on the construction of Shasta and Friant dams. Officers for the Forum for the rest of the year are as follows: R. L. Richardson, president; Alexander Russell, vice-president; and Edwin F. Sullivan, secretary.

SAN DIEGO SECTION—*June 27:* "How to Be a Good Public Speaker" was the topic of discussion at this session, the speaker being Roy Edwards, personnel manager for the San Diego Consolidated Gas and Electric Company.

SAN FRANCISCO SECTION—*June 18:* Prizes of Junior membership in the Society were awarded to Niels J. Schultz, Jr., of Stanford University, and Steven E. Graham, Jr., of the University of Santa Clara. The technical program consisted of a talk by C. F. Tolman, emeritus professor of economic geology at Stanford University, whose subject was the geological history of California. *Junior Forum, May 28:* A paper on the organization and functions of the National Resources Planning Board was presented by Donald F. Griffin, associate planning technician for the Board. An open discussion on "What Should an Engineering Education Include to Improve the Cultural Background of the Engineer?" concluded the program.

SOUTH CAROLINA SECTION—*Charleston, June 21–22:* Joint meeting with the South Carolina Society of Engineers, consisting of a technical session and banquet on the 21st and two inspection trips on the 22d. The principal speaker at the banquet was Gen. C. P. Summerall, president of The Citadel (Military College of South Carolina). The following day there was an inspection trip in the morning to the Pinopolis Dam site of the Santee-Cooper Project, where the lock, dam, and power house were viewed, and in the afternoon the group visited the Santee Dam site and observed the progress of construction on the dam and spillway.

SPOKANE SECTION—*May 10 and 18:* The first of these sessions was a regular luncheon meeting followed by a general business discussion. On the 18th a number of the members and their guests journeyed to Grand Coulee Dam, where they were escorted in groups of ten on a complete tour of the project. In the evening all assembled at the contractor's mess hall for dinner, after which Ed Craig discussed the installation of the penstocks. Mr. Craig is on the engineering staff of the U.S. Bureau of Reclamation. During a brief business meeting Fred Sharkey was elected first vice-president of the Section to fill the vacancy caused by the death of Prof. Isaac N. Carter.

TACOMA SECTION—*June 11:* A symposium on highway design and construction was the feature of the technical program. Those participating were Henry G. Porak, Carl F. Fritts, and D. H. Herrold, all on the engineering staff of the Washington State Highway Department.

TENNESSEE VALLEY SECTION—*Chattanooga Sub-Section, June 11:* The technical program consisted of the reading of a paper on "Ethics for Sales Engineers" by James Pou, engineer aide for the TVA at Chattanooga. The paper was Mr. Pou's entry in the Daniel W. Mead Prize contest. A. S. Fry, president of the Section, then gave an illustrated talk on the Tennessee Valley. *Knoxville Sub-Section, June 11:* At this session another young man—Allen Jones, Jr., sales engineer for the Tennessee Metal Culvert Company, Knoxville—presented his entry for the Mead Prize. He was followed by Arthur S. Jandry, director of personnel for the TVA, who gave a talk entitled "Public Personnel Administration and the Engineering Profession." An enthusiastic discussion of Mr. Jandry's talk concluded the meeting.

TOLEDO SECTION—*June 8:* The meeting took the form of an inspection trip to the recently completed coal unloading docks of the Pennsylvania Railroad at Sandusky, Ohio. Paul D. Miller, of the Pennsylvania Railroad Company, conducted the tour and described the important features of the project.

TRI-CITY SECTION—*Muscatine, Iowa, May 16:* Preceding a dinner meeting, Herman S. Smith, resident engineer for the Stanley Engineering Company on the Muscatine Municipal Power Plant project, conducted a group of engineers about the project. The technical program, held later in the evening, consisted of talks by C. M. Stanley, president of the Stanley Engineering Company, and F. P. G. Halbfass, county engineer of Muscatine County. The former discussed the work of the Rural Electrification Administration in the vicinity, while Mr. Halbfass spoke on "The Muscatine County Road Program." *Iowa City, Iowa, May 27:* Joint meeting with the Iowa City Engineers Club. Following an inspection trip to the dam site for the proposed Coralville Reservoir on the Iowa River, papers describing the Coralville flood control project were presented by two engineers in the U.S. Engineer Office at Rock Island, Ill. M. C. Lorenz discussed the foundation investigations for the project, while T. J. Rodhouse presented a paper on the use of state plane coordinate systems in connection with the flood control surveys and mapping.

UTAH SECTION—*Junior Forum, June 21:* The meeting took the form of a field trip through the Wasatch Exchange of the Mountain States Telephone and Telegraph Company. Members of the staff explained the telegraph and teletype department, the radio network and telephoto division, and many other features of interest.

WISCONSIN SECTION—*Milwaukee, May 9:* The recipient of the Section's award of Junior membership in the Society—Ray Dorien, of Marquette University—gave a résumé of his paper entitled "Flood Control on the Milwaukee River in Milwaukee County." George W. Hardgrove then read a résumé of his paper on "Pea Cannery Waste Treatment." As second prize winner, Mr. Hardgrove was awarded a standard engineering handbook of his own selection. *Appleton, June 7:* The speakers on the technical program were D. W. McGlashon, regional engineer of the Portland Cement Association at Kansas City, and Leroy Empey, of the Green Bay office of the Wisconsin State Highway Commission. Mr. McGlashon gave a talk on "Belt Line Highway Analysis," while Mr. Empey described belt line highway work in the Fox River valley.

ITEMS OF INTEREST

About Engineers and Engineering

CIVIL ENGINEERING for September

"HAS SAFETY for construction workers kept pace with progress in construction methods?" ask John W. Cowper and Harry O. Locher, in CIVIL ENGINEERING for September. Realizing that just talking about accident prevention doesn't impress most of us," they talk mainly about accidents instead—"accidents that should not have occurred." Their article, "Safety Pays Dividends," should be on the "must" list of every construction man, from gang foreman to chief engineer.

Successful attack on one specific construction hazard is described in another article in the same issue—"Silica Dust Control at Hiwassee Dam," by L. P. Hatch and D. F. Shaw. Water sprays and air exhausts were the methods used.

In the sanitary engineering field, R. E. Lawrence contributes a paper on the new water supply for Wichita, Kans. Unlike most water supply developments of recent years, the Wichita project is not required to relieve a water shortage; on the contrary, the city is abandoning an abundant supply in favor of a less mineralized and more potable source. The new deep wells, 25 in number and located 18 to 33 miles northwest of the city, are intended to develop 30 mgd.

"Reconnaissance Surveys" is the title of an article by L. B. Roberts, also on the September schedule. Surveyors have evolved a wide variety of reconnaissance methods, each with modifications to suit particular circumstances, and these Major Roberts describes briefly, buttressing his technical observations with illustrations from several continents.

Other attractive titles in September include "Horse-and-Buggy Days of Bridge Building," by H. S. Tullock; "What Do We Know About Concrete Slabs?" by Nathan M. Newmark; and "Development and Maintenance of a Navigable Channel in the Missouri River," by D. R. Neff. And of course the issue will include O. N. Floyd's second article on modern earth-dam construction methods.

Stamp Commemorates Late Sydney B. Williamson

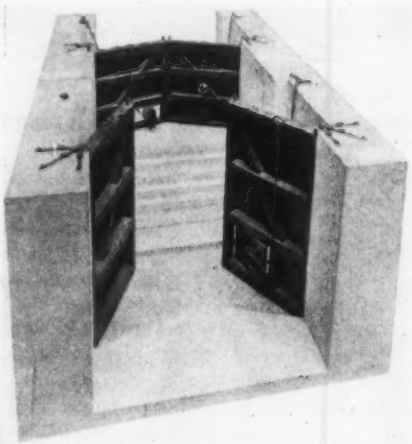
OF SPECIAL interest to the engineer as well as to the philatelist—sometimes it is one and the same person—is a new stamp to perpetuate the memory of a famous engineer, the late Sydney B. Williamson, M. Am. Soc. C.E. One of Colonel Williamson's notable successes, that for which he is most widely known, was as division engineer of the Pacific Division in the Panama Canal work. His illustrious service in this capacity is responsible for his commemoration on the present stamp.

It is a 30-cent issue of the Canal Zone, released on April 15, 1940, the 75th anniversary of his birth. A fascinating memoir of Colonel Williamson, from the pen of Col. George R. Goethals, son of Gen. George W. Goethals, has recently been printed by the Society. In this memoir (to be included in the forthcoming Vol. 105 of TRANSACTIONS) Colonel Goethals remarked that the most signal honor to the late Colonel Williamson "was the designation by the Governor of the Panama Canal of his likeness to appear on the 30-cent postage stamp of the permanent issue of the Canal Zone. It is especially noteworthy in Colonel Williamson's case, for this honor has otherwise been reserved solely for certain of those who held the rank of commissioner during the construction period of the canal."

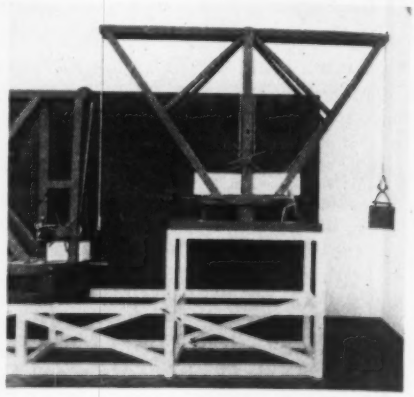
Among the other cases referred to may be mentioned that of General Goethals, who was commemorated on a 3-cent stamp of the Canal Zone issued in 1934. Canal Zone stamps have also been issued with the likenesses of Maj. Gen. H. F. Hodges (10¢ orange), Brig. Gen. William L. Sibert (14¢ dark blue), and Rear Admiral H. H. Rousseau (20¢ olive brown)—all members of the Society, whose memoirs have been published in past volumes of TRANSACTIONS. General Goethals also was a member of the Society.

Leonardo da Vinci Exhibit

A COMPREHENSIVE collection of the works of Leonardo da Vinci has been made by the Italian government and sent to the United States for exhibition. It is now installed at the Museum of Science and Industry, Rockefeller Center, New York. Eighteen roomfuls of this material, including volumes of original autograph writings, with plans for flying machines, submarines, and differential gear, as well as full-size or scale models, have been brought from Italy. They illustrate the fact that this remarkable combination of engineer, artist, and architect was 400 years ahead of his day. For example, he planned cities of the future with superimposed highways, designed circular forts with underground passages, invented a printing press and even a diving apparatus, which he was afraid to disclose because of fear it would be misused. A variety of similar ideas fill 14 volumes of his notes written in his curious right-to-left handwriting.



MODEL OF CANAL LOCK GATES BUILT FROM DA VINCI'S SKETCH
Doors Swing Inward—Valves in Bottom



A "LIFTING MACHINE" OPERATED BY TWO ARMS WITH COUNTERWEIGHTS
This Crane Model Is One-Fifth of the Size Contemplated by da Vinci

As in the case of the exhibition in Milan, Italy, the American display includes data on Leonardo's life, in his native Italy in many localities and under a variety of auspices, and finally in France where he died. The exhibition throws light on his researches in the fields of mathematics, astronomy, geodesy, cosmography, geology, and hydraulics, and the laws he discovered, with their numerous applications, such as his design of machines for the reclamation of the Pontine Marshes. One division, on optics, shows Leonardo's studies on the anatomy of the eye and on the field glass, which he invented. Models of musical instruments show another side of his tremendous imaginative ability.

One model of flying apparatus is over 23 ft long. Seven models illustrate Leonardo's ideas on city planning, of which the largest is 12 by 10 ft. Military models, covering some ideas that are being put in practice even today, are covered by 22 models, including bridges and forts, machine guns, and breech-loading cannon.

This many-sided man made studies of hydraulic machines; 19 models illustrate canals, dams, sea locks, basins, bridges, and related structures. One shows an ingenious gate in a lock—when the capstan is turned the gate slowly drops into a pocket allowing the water to pass into the canal.

One of the models might suggest a modern dam, built in a deep curving canyon, with a canal conveying the water along the mountain side. Below the dam a spillway discharges surplus water through openings like those in many great dams today.

In the field of mechanical engineering, Leonardo's inventions are almost too many to chronicle. Models in the present exhibit illustrate such inventions as the variable-speed drive, rolling mill, roller bearings, two types of printing press, screw-threading machine, a forerunner of the modern steam shovel, monkeywrench, steam engine, and similar remarkable ideas.

Any engineer who takes the time to study this exhibit will be fascinated by the genius of Leonardo da Vinci.

Prof. N. G. Neare's Column

Conducted by

R. ROBINSON ROWE, M. AM. SOC. C.E.

AT THE June meeting of the Engineers Club, Prof. N. G. Neare had proposed an interesting problem. Given the base and top diameters of the pedestal under the sundial at the North Pole, which pedestal was a right truncated cone, to compute its height from the "magical" property that a funicular line turning thrice about the cone from top to base completed exactly two of the turns above mid-height. Last evening the matter was called up under "unfinished business" by several members who claimed to have solutions. The professor examined them, and gave each an "A."

"I am not surprised at all," he said. "It was an exercise in trigonometry rather than a puzzle, for there wasn't a 'catch' in it. I hoped you might waste some time looking for the catch that wasn't there.

"Actually it was akin to the 'spider and fly' puzzle, solved by developing the inner surfaces of a room. For the pedestal problem, the truncated cone may be developed three times continuously (Fig. 1). Then the funicular line runs diagonally across the triple development. With some trigonometric juggling, the conditions may be expressed:

$$8rk^2 - 2r\,(l + r)k = l + 3r$$

where r is the ratio d/D between top and base diameters, and k is the cosine of V, the vertex angle of the developed cone. In this case, $r = 16/24$, whence cos $V = k = 0.9867309$. Then the slant height is $180D(l - k)/V = 12.842$ ft, and the vertical height would be 12.838 ft. Truly a well-proportioned monument!

"I am always meeting interesting people at our meetings here, and tonight I met a man after my own heart, Ken Bridgewater, a Hybrid Engineer. Ken just proposed to me a modern version of the 'monkey and cocoanuts affair,' and I am asking him to repeat the version for the rest of you."

"Well," said Bridgewater without further introduction, "it seems that four dictators fleeing from the inevitable were shipwrecked on an island where they found a limited supply of monkeys and cocoanuts. Having first regimented the monkeys by bluff, threat, and promise, they directed the immediate harvest and impounding of all the cocoanuts, subject to a division the next day. Then all retired.

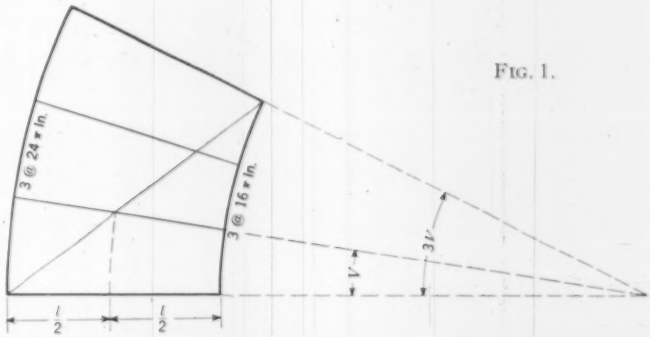


FIG. 1.

"Early in the night, the Brown Dictator, sleepless from distrust of his fellows, decided upon a *putsch*. Stealthily he divided the harvest into 5 equal portions and cached two portions for his own. Of course the division left a remainder of one cocoanut, as in the original affair; this the Brown Dictator ate while the hungry monkeys looked on. Then he went back to bed.

"The Red, Black, and Yellow Dictators each woke up in turn during the night and each repeated the *putsch*, each caching two portions for himself, leaving only one portion for each of the others and making a snack of the recurrent remainder of one cocoanut.

"Then came the dawn and the reckoning. Distrust ripened into oratory. But the *faits accomplis* were sustained and a basis was found for dividing the remains of the harvest, though each dictator kept his fingers crossed. Since each wanted two shares, division was made into 8 equal portions. Inevitably one cocoanut remained and this led to a battle royal.

"Seizing the opportunity, the monkeys rushed in and completed the demise of the dictators. They found all the caches, but didn't divide or count, so you'll have to figure out how many cocoanuts were gathered."

And the professor added, "Neither Ken nor I have tried to solve the problem yet, so we can all start from scratch."

The Native Method of River Improvement in the Upper Left River

By WEN-PANG LI, ASSOC. M. AM. SOC. C.E.

CHIEF OF DESIGNING DEPARTMENT, PEARL RIVER CONSERVANCY BUREAU, NANNING, CHINA

WHAT HAS been done in southwestern China in the way of river improvement without modern machinery of any kind, and under war conditions, should be of interest to civil engineers in all lands. When the Pearl River Conservancy Bureau was evacuated to Nanning in October 1938, after the fall of Canton, we were called upon to improve the Upper West River for immediate navigation without any modern machinery in hand.

COOLIES ON THE SAMPAN NOSE THE SCRAPER INTO THE RIVER BED WHILE IT IS DRAWN SHOREWARD BY THE CAPSTAN

West River is one of the three large tributaries of Pearl River. Its upper part, the Left River, has its source in Indo-China and runs easterly through Lungchow, Chungshun, and Tao-low to Nanning, a total course of about 210 miles (Fig. 1), thus providing a direct navigable channel from Indo-China to the interior of Kwangsi Province. The annual cargo through this only intercountry water transportation route in the Southwest amounts to 33,000 to 55,000 tons.

The Left River has many rapids and ox-bows, and in low-water season —from December to May—the depth over the rapids is only a few inches to two feet. Boatmen must lighten their cargoes, or even carry their boats bodily over the ridges of rapids. Where the rapids can be navigated at all, the current is so swift that the boats must be dragged upstream by means of a capstan, with the rope knotted around some rock ashore; and steamers going downstream turn their heads upstream to decrease the speed. As the rocks are submerged, shipwrecks are frequent.

The river bed in general is of course sand, pebbles, and boulders, loosely mixed, with an occasional outcrop of rock or conglomerate. In the stretch from Ping-Yi gate to Lungchow (28 miles) there are

FIG. 1. THE LEFT RIVER—A STRATEGIC LINK BETWEEN NANNING AND INDO-CHINA

35 rapids, and in that part from Lungchow to Nanning (186 miles) there are 56.

Because of the need for speed and the lack of money, we confined our attention to improving these rapids. The rapid-by-rapid surveying work, which included profile and cross sections of the improved section, quantity of rock, and the ascertained low-water level, was completed in one month by five surveying parties of three engineers each. Our project called for dredging the channel to a depth 1 m below low-water level and a bottom width of 10 m; side slopes were 1 to 4 in sand and pebble river bed, and 1 to 1 in rock cuts. The work consisted mainly of rock blasting and gravel scraping, and was finished in less than three months.

Blasting above the water surface was done with gunpowder, while for underwater work we used dynamite. Without a single pneumatic drill at our disposal, the workmen resorted to hammer and chisel to punch the holes, 1 to 2 ft deep, into the rock. About 4 to 5 man-days were required to blast off each cubic yard of submerged rock. The contract price was from $10 to $15, Chinese national currency, for submerged rock, and $2.50 to $6.00 for dry rock, per cubic yard.

Lacking dredges, the dredging process was carried out with capstans and scrapers, all locally made. The scraper, as shown in Fig. 2, is made of steel bars woven with steel strips and attached to wooden handles. Each scraper weighs about 150 to 200 lb. There are two kinds of capstan, one to be erected on the deck of a boat, and the other for use on shore. The boat capstan is a short wooden column approximately $1\frac{1}{2}$ ft in diameter, with one end pivoted and the other carrying six to eight lever arms. The land capstan, as shown in the photograph, is simply a pine post with a wooden collar on top, fastened to the ground with cables and stakes, and having a cushion at the bottom to keep the pivot in position. The lower part of the post is of course made larger by nailing on wooden strips. There are also 6 to 8 lever arms.

A hemp or bamboo rope is fastened to the scraper's rings at one end and circles around the capstan at the other end. Two coolies in a sampan maneuver the scraper into the shoal and press it hard into the bed of sand and pebbles. As other coolies turn the capstan on shore or in a boat, the scraper is drawn toward the capstan and thus dredges the sand and pebbles away from the center line of the section. About 20 ft outside the edge of the design channel, the dredged material is "unloaded" and deposited to form a low dike of loose sand and pebbles to confine the water in dry season, thus maintaining the required depth.

It required about five minutes to complete one run of the scraper on a travel of 50 ft. Each capstan-and-scraper crew consisted of 12 to 15 coolies and had an output of 8 to 11 cu yd per day. The contract price was $2.50 to $3.00 per cu yd.

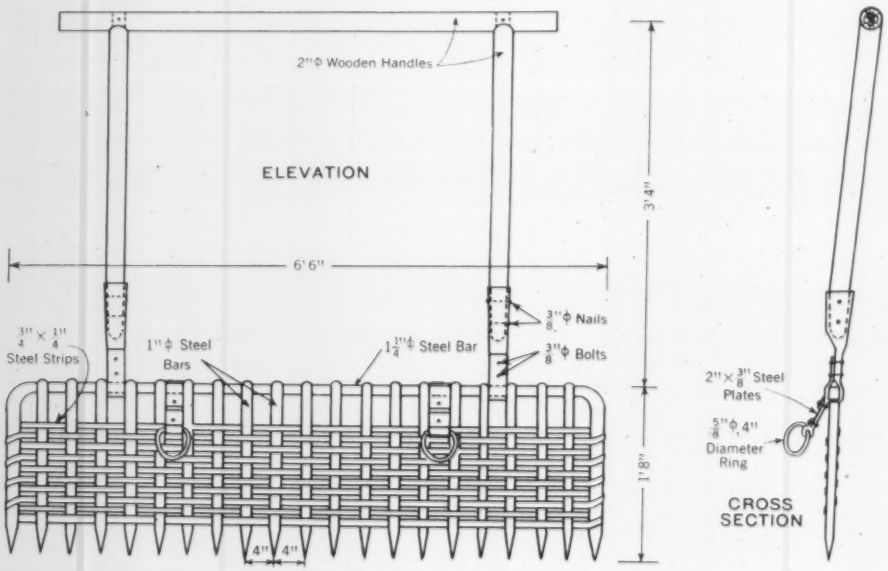


FIG. 2. THE SCRAPER

Maintaining Leather Book Bindings, Like Those of TRANSACTIONS

BOOK OWNERS are frequently disturbed by finding that leather bindings have lost their strength and are crumbling to pieces. Because of this difficulty, as sometimes noted in the case of the half-morocco bound TRANSACTIONS, the Society's Committee on Publications appealed to the Engineering Societies' Library for advice. The following comments are the result.

The difficulty does not seem to arise through age, for old bindings are often better preserved than modern ones; in fact, when very old they usually are. Deterioration is probably caused by several factors, and its causes are still uncertain. The high sulfuric-acid content of modern city air, the dry atmosphere of our houses today, and exposure to direct sunlight are considered harmful.

It has long been common knowledge that the leathers of today are much less satisfactory for book bindings than those of a hundred years ago. For this, modern methods of tanning have been blamed, on the theory that they leave residual sulfuric acid in the leather. On this theory, some libraries have turned to cloth for bindings or to leather tanned in Nigeria by native methods.

A few years ago a British study led to the interesting conclusion that the rapid decay was not so much the result of the presence in the leather of an injurious body such as sulfuric acid, as of the absence of water-soluble salts of organic acids which exert a protective action. These salts are present in old leathers but not in modern ones, having been washed out of the latter by the tanner in order to enable him to dye his product to the dead-level shade demanded by the binder. Leathers are now being made which contain sufficient protective salts to make them durable, it is thought, although definite conclusions must await the passage of years.

In the attempt to stave off the decay of leather, many preservative treatments have been proposed. Usually these are based on the assumption that the addition of grease will prevent the absorption of sulfuric acid from the atmosphere and also lubricate the leather. Obviously, surface applications can do little more than prevent further absorption of sulfur gases, and improve the appearance of the binding.

There are many formulas for dressings, some proprietary ones for which large claims are made, others advocated by various libraries. Lydenberg and Archer, in *The Care and Repair of Books*, give the following formula:

"Take four parts of lanolin of about the consistency of lard and warm it slowly until it becomes fluid or free running. To this add six parts of neatsfoot oil (pure, filtered, wholly neutral), mixing the two thoroughly. When cool, apply the mixture with a flat varnish brush of proper size, or a soft cloth or pad. Let the books stand for a few hours or over night until the oil is absorbed. When dry, rub with

a soft cloth. If more polish is required apply a small quantity of castor oil with a soft cloth or pad, and when it is dry polish with a chamois or sheeps' wool polisher."

It is recommended that this treatment be made on newly bound books when received, repeated after six months, and again after a year.

Other formulas are readily available. One prepared by the U.S. Department of Agriculture for the Library of Congress is:

Lanolin, anhydrous, U.S.P.	30%
Japan wax	5%
Castor oil, U.S.P.	12%
Sodium sterate	3%
Water, distilled	50%

Brief Notes from Here and There

NEW president of the American Institute of Electrical Engineers for the year beginning August 1, 1940, is Dr. R. W. Sorensen, head of the department of electrical engineering at California Institute of Technology. Other new officers are as follows: vice-presidents, Everett S. Lee (Schenectady), J. W. Barker, M. Am. Soc. C.E. (New York City), K. L. Hansen (Milwaukee), J. L. Hamilton (St. Louis), and A. LeRoy Taylor (Salt Lake City); directors, T. F. Barton (New York City), M. S. Coover (Ames, Iowa), and R. G. Warner (New Haven, Conn.).

* * * *

ANNOUNCEMENT is made of the award, for the current year, of the Marston Medal from Iowa State College to James W. Hook, mechanical engineer and manufacturer of New Haven, Conn. This medal, highest honor in the engineering division of the college, is named for Anson Marston, Past-President and Honorary Member of the Society. It is administered by a Board which includes representatives of the national Engineering Societies. In this connection, John W. Alvord, Hon. M. Am. Soc. C.E., serves for the Society.

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"THIS Our America," a series of broadcasts currently being presented by the National Broadcasting Company with the cooperation of the National Resources Planning Board, includes a variety of topics of special engineering interest. "Science and Invention," "Transportation and Communication," and "Production and Consumption" are the subjects of the July 31, August 7, and August 14 programs, to be heard from 8:00 to 8:30 p.m., E.D.S.T.

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WITH THE adoption in June of its new constitution and by-laws, the Water Works Manufacturers' Association became the Water and Sewage Works Manufacturers' Association, and its membership was opened to manufacturers of materials, supplies, and equipment used in connection with sewerage and sewage disposal.

* * * *

IN A CURRENT REPORT to the Society for the Promotion of Engineering Education, Dr. C. F. Scott comments on present numerical trends in engineering education. Undergraduate students in 150 schools, including Canada, have increased about 30% in three years to 106,000. Similarly candidates for the master's degree now number 4,700, and for the doctor's degree 850, in each case a doubling in three years. The undergraduate increase is attributed "partly to the employment situation but mainly to the growing regard for engineering training as a preparation for careers in industry, business, and public service."

* * * *

A SOIL mechanics conference is announced by the Society for the Promotion of Engineering Education, to be held September 2–6 at Purdue University, West Lafayette, Ind. Chief purpose of the meeting is to provide opportunities for discussing "problems incident to the presentation of courses in soil mechanics." Further information can be secured from the School of Engineering at the University.

* * * *

A THREE-DAY symposium on hydrobiology is scheduled for September 4–6 at the University of Wisconsin, Madison. On the "Sanitary Science Section" programs are such topics as "Hydrobiology and Malaria Control," "Microbiology of Sewage and Sewage Treatment," "Quantitative Biochemical Relations in the Activated Sludge Process," and "Swimming Pool Sanitation." Members of the American Society of Civil Engineers are welcome to attend and can secure full information from Lewis H. Kessler, M. Am. Soc. C.E., in the College of Engineering of the University.

* * * *

ACCORDING to *Public Safety* of the National Safety Council, the work of traffic engineers is growing in importance. Most men in this type of work are either in municipal engineering departments or in public safety departments. As shown by a recent survey, only 18% of the traffic engineers were reported as a part of the police department. "The trend is definitely toward placing the traffic engineer in a position coordinately equal, rather than subordinate, to the police department."

NEWS OF ENGINEERS

Personal Items About Society Members

LAWRENCE ORTOLANI is now embankment engineer for the Texas State Highway Department, with headquarters at Austin. Mr. Ortolani was formerly resident engineer for the Department at Cleburne, Tex.

E. W. STEARNS has been appointed chief engineer for the P. T. Cox Construction Company, at 270 Broadway, New York City.

ROBERT W. ABBETT, until recently associate professor of building construction at Union College, has accepted a position in the civil engineering department at Columbia University

L. C. GROSSMANN, who is on the staff of the Public Buildings Administration of the Federal Works Agency, has been transferred from the position of assistant district engineer to that of senior construction engineer and assigned to supervise the construction of a new post office at East Boston, Mass.

EARL R. BENNETT, previously senior inspector on contruction at the Mare Island Navy Yard, Mare Island, Calif., is now serving as a reserve officer on active duty at the Naval Submarine Base, New London, Conn.

LEO D. BOSWELL has accepted a position as chief engineer for the Star Manufacturing Company, of Oklahoma City, Okla. He was formerly with the Tulsa Boiler and Machinery Company, at Tulsa, Okla.

JOSEPH GOODMAN retired on July 8 as commissioner of the New York City Department of Water Supply, Gas and Electricity after almost forty years in the service of the city. His first city post was with the old Bureau of Water Supply in 1901.

VINCENT R. CARTELLI has resigned as structural steel draftsman in the Bureau of Sewers and Highways of the New York City Department of Public Works to take a position as structural designer with the Carbide and Carbon Chemicals Corporation (a unit of the Union Carbide Company), at South Charleston, W.Va.

ROBERT W. VOSE, formerly instructor in charge of the Materials Laboratory at the Harvard Engineering School, is now director of research for the Chicopee Manufacturing Corporation at Chicopee Falls, Mass.

WALTER G. WILL has been made commander in the U.S. Coast Guard, with headquarters in the Leader Building, Cleveland, Ohio. Until recently Mr. Will was superintendent for the U.S. Lighthouse Service at St. Louis, Mo., his change in position resulting from the recent merger of the Lighthouse Service and the Coast Guard.

MERLIN D. COPEN, previously graduate assistant at Kansas State College, has accepted a position as junior engineer in the design department of the Kansas State Highway Commission. He is located at Topeka.

MARSHAL MCCORD is now senior bridge draftsman for the Maryland State Roads Commission at Baltimore, Md. He was formerly in the employ of Modjeski and Masters at Harrisburg, Pa.

DAVID E. DONLEY, for the past six years hydraulic engineer for the Tennessee Valley Authority at Knoxville, Tenn., has been transferred to the U.S. Engineer Department at Large, Washington, D.C., where he will be hydraulic engineer in charge of the survey for flood control in the Anacostia River Basin.

WILLIAM GRANT, former senior engineer for the PWA at Fort Worth, Tex., is now associated with Freese and Nichols in Fort Worth.

B. F. WILLIAMS has been appointed engineer by the Texas Board of Health to investigate methods of disposal of salt water in the east Texas oil field.

EDWIN C. ECKEL and BERLEN C. MONEYMAKER, respectively chief geologist and assistant chief geologist for the Tennessee Valley Authority, have moved the staffs and offices of the geologic division of the TVA from Knoxville to Chattanooga, Tenn.

WILLIAM A. BRENNAN resigned on June 1 as Commissioner of Public Safety of White Plains, N.Y., after fourteen years in the service of the department. At present Mr. Brennan is maintaining a consulting practice at 110 Mamaroneck Avenue, White Plains.

J. P. SARTZ, until lately resident engineer inspector for the PWA at Harrisburg, Pa., has accepted a position as construction superintendent for the Utility Management Corporation, of Reading, Pa., in which capacity he is supervising the construction of a boiler installation for the South Carolina Electric and Gas Company at Parr, S.C.

EDWIN E. GIBSON is now employed as assistant civil engineer in the Public Works Division at the Charleston Navy Yard, Charleston, S.C. He was formerly junior engineer in the U.S. Engineer Office at Cincinnati, Ohio.

FRANCIS W. HERRING, executive director of the American Public Works Association, Chicago, Ill., has been granted a leave of absence from this post until January 1941 in order to accept appointment as assistant director of the National Resources Planning Board in Washington. Mr. Herring will head one of the newly created divisions of the Board in carrying out the provisions of the Federal Employment Stabilization Act.

DONALD H. CONNOLLY, colonel, Corps of Engineers, U.S. Army, now stationed at Fort Logan, Colo., has been named head of the U.S. Engineer Office at Pittsburgh, Pa. CAPT. HERBERT D. VOGEL, who has been stationed at the engineering school at Fort Belvoir, Va., has been appointed assistant district engineer at Pittsburgh.

JOHN S. WILEY, previously engineer with the Bureau of Industrial Hygiene, Indiana State Board of Health, has accepted a position as assistant sanitary engineer for District No. 4 of the U.S. Public Health Service. His headquarters are the U.S. Marine Hospital at New Orleans, La.

C. H. CUNNINGHAM, lieutenant colonel, Corps of Engineers, U.S. Army, has been ordered to begin new duties with the 8th Engineer Squadron at Fort McIntosh, Tex. At present Colonel Cunningham is assistant to the division engineer of the North Atlantic Division of the U.S. Engineer Office.

GEORGE H. SAGER, JR., has resigned as executive director of the Louisville (Ky.) Municipal Housing Commission, to join the staff of Ford, Bacon and Davis, Inc., of New York City.

CLARK KITTRELL, has been promoted from the rank of major, Corps of Engineers, U.S. Army, to that of lieutenant colonel. At present he is at New Orleans, La.

C. L. GARNER was awarded the honorary degree of doctor of engineering by North Carolina State College on June 3. A list of other members of the Society thus honored appeared in the July issue of CIVIL ENGINEERING.

J. MONROE JOHNSON, since 1935 Assistant Secretary of Commerce, with headquarters in Washington, D.C., has been named a member of the Interstate Commerce Commission. Mr. Johnson has jurisdiction over all transportation activities of the Department of Commerce.

CLARENCE W. DUNHAM, chief structural designer for the Phelps-Dodge Corporation, New York, N.Y., has been appointed assistant professor of civil engineering at Yale University, his new work to start in September.

CECIL E. PEARCE is in the U.S. Engineer Office at Denison, Tex., where he will remain for eight or nine months working on power-plant design before returning to his duties as principal hydraulic engineer for the Tennessee Valley Authority at Knoxville, Tenn.

BEVERLY C. DUNN, colonel, Corps of Engineers, U.S. Army, is being transferred from Fort Lawton, Wash., where he was commander of the Sixth Engineering Battalion, to Honolulu, where he will be district engineer for the U.S. Engineer Office.

A. H. HORTON, who is hydraulic engineer for the U.S. Geological Survey, was recently placed in charge of the Middle Atlantic States district office of the Water Resources Branch of the Survey. His headquarters are in the new engineering building at the University of Maryland.

ADOLPHUS MITCHELL, until lately designer in the bridge department of the North Carolina State Highway and Public Works Commission, has been promoted to the position of traffic engineer for the Commission.

ROBERT L. HOUSTON has been appointed assistant city engineer of Tucson, Ariz.

RICHARD R. TOWERS is now assistant engineering aide in the Bureau of Construction and Repair of the U.S. Navy Department, with headquarters in Washington, D.C. He was formerly junior engineer and draftsman for the Brown Company at Berlin, N.H.

DE WITT C. GREER has been named state highway engineer of Texas to succeed JULIAN MONTGOMERY, who has resigned because of ill health. Mr. Greer was promoted from the position of chief engineer of construction and design in the State Highway Department.

FRED C. PLUMMER, previously chief design engineer for Cuyahoga County (Ohio), with headquarters in Cleveland, has taken up residence in Warren, Pa., where he will be chief research engineer for Hammond Iron Works, of New York City and Warren. During his years in Cleveland, Mr. Plummer was in charge of the structural design of many important projects, including the Zeppelin dock at Akron.

WILLIAM H. OVERSHINER, who has for some years held a commission as lieutenant commander in the Civil Engineer Corps of the U.S. Naval Reserve, was recently ordered to active duty as project manager of public works in charge of all construction work at the Naval Air Station at San Pedro, Calif.

JAMES D. TAYLOR is now office assistant in the office of vice-president of operations for the Great Northern Railway Company at St. Paul, Minn. He was formerly a draftsman for the Chicago, Burlington and Quincy Railroad.

DECEASED

OLE ANDREW ABELSON (M. '27) structural engineer for the Tacoma Water Department, Tacoma, Wash., died sometime ago, though word of his death has just reached Society Headquarters. He was 61. A native of Norway, Mr. Abelson was brought up and educated in this country. From 1915 to 1917 he was with the Tacoma Smelting Company; from 1918 to 1919, with the Garfield (Utah) Smelting Company; and from 1919 to 1923 with the Tacoma Water Department. After three years on the Cushman Power Project, he returned to the Tacoma Water Department as structural engineer.

WESTERN RADFORD BASCOME (M. '17) consulting engineer of New York City, died on June 14, 1940, at the age of 73. From 1897 to 1903 Mr. Bascome was assistant engineer on the construction of the Williamsburg Bridge in New York City; from 1905 to 1910, resident engineer on the construction of Manhattan Bridge; and from 1910 to 1924, assistant to the chief engineer of the New York City Department of Bridges (now Plant and Structures). Later he was with the New York City Department of Markets and the Board of Water Supply.

ARTHUR WILLIAM PAUL BLOHM (Assoc. M. '37) assistant sanitary engineer, Maryland State Department of Health, Baltimore, Md., died in that city on June 19, 1940. Mr. Blohm, who was 40, had been in the State Department of Health since 1919—first as engineer assistant and, since 1923, as assistant sanitary engineer.

JOHN BENJAMIN BODY (M. '00) civil engineer for S. Pearson and Son, of London, England, died in that city on May 23, 1940, at the age of 75. Early in his career Mr. Body was with the Metropolitan (London) Board of Works and the Milford Haven Dock Works. In 1890 he went to Mexico, where he remained for a number of years, serving as chief engineer on the construction of the Vera Cruz Harbor Works and as chief engineer and general manager of the National Tehuantepec Railway.

LAURANCE JOHNSON CARMALT (M. '07) retired consulting engineer of New Haven, Conn., died on June 24, 1940, at the age of 73. Mr. Carmalt served in an engineering

capacity with the Norfolk and Western Railroad, the Southern Railway, the New York Central, the Long Island Railroad, and the New York, New Haven and Hartford, being with the latter from 1911 to 1921. For a time, also, he was with the U.S. Corps of Engineers in Puerto Rico.

WALTER WHALEY CURTIS (M. '88) retired consulting engineer of Denver, Colo., died at his home in that city on June 29, 1940, at the age of 76. For many years Mr. Curtis maintained a consulting practice in Chicago. He then (1913) went to Colorado Springs, where he was president of the Rapson Coal Mining Company and the Curtis Coal Company. He retired several years ago.

WALLACE HAYNES HALSEY (M. '31) of Southampton, N.Y., died recently at the age of 58. From 1904 to 1912 Mr. Halsey was engineer and surveyor for the Suffolk County (N.Y.) Shell Fisheries, and from the latter year on he maintained an engineering and surveying practice at Southampton. At one time he served as special engineer to the Bureau of Marine Fisheries of New York State.

JOHN PAUL HARTMAN (Jun. '35) associate engineer, Corps of Engineers, U.S. Army, Denison, Tex., died there on June 9, 1940. Following his graduation from Purdue University in 1930, Mr. Hartman did postgraduate work at M.I.T. In 1934 and 1935 he was an assistant in the soils laboratory at Zanesville, Ohio, and for the next three years was at Fort Peck Dam. About two years ago he was transferred to the U.S. Engineer Office at Denison, where he was in charge of the design of the embankment and directed all the investigations in constructing the rolled-fill dam.

RALPH MODJESKI (M. '97) retired consulting engineer, died in Los Angeles, Calif., on June 26, 1940, at the age of 79. Born in Poland, a son of Helena Modjeska, the famous actress, Mr. Modjeski was educated in that country and Paris. In 1885 he took a position with the Union Pacific, leaving there in 1893 to open a consulting office in Chicago. In the years that followed Mr. Modjeski became famous as a bridge builder, the list of structures on which he was prominently employed including the Quebec Bridge across the St. Lawrence; the Delaware River Bridge connecting Philadelphia and Camden, N.J.; the Ambassador Bridge at Detroit; and the San Francisco–Oakland Bay Bridge. He was the recipient of many honors, including the Washington Award, the John Fritz Gold Medal, and the Franklin Medal of the Franklin Institute. From 1904 to 1906 Mr. Modjeski served as Director of the Society.

ALEXANDER POTTER (M. '31) consulting engineer of New York City, died at Great Barrington, Mass., on June 20, 1940, at the age of 74. Dr. Potter had been in private practice as a sanitary and hydraulic engineer for almost fifty years. He was also chief engineer of the Joint Sewerage Commission for eleven municipalities in New Jersey, and had been associated with water supply projects in more than 150 cities in this country and Cuba. In 1935 he was appointed one of the three members of the Rockland–Westchester Hudson River Crossing Authority.

CHARLES DE LA CHEROIS PURDON (M. '86) died at Paris, Tex., on June 2, 1940, at the age of 89. Mr. Purdon was born in Ireland and educated at Queens University, Belfast. For some years he was chief engineer of the St. Louis and San Francisco Railroad, and from 1910 until his retirement in 1930 he was, successively, chief engineer, consulting engineer, and valuation engineer for the St. Louis, Southwestern Railway (the Cotton Belt Line). Before moving to Texas about a year ago, he lived for many years in St. Louis.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

LOUIS DAVIDSON RICKETTS (M. '04) of Pasadena, Calif., died on March 4, 1940, at the age of 80. From 1883 to 1885 Dr. Ricketts was surveyor and superintendent of the Colorado Mines; from 1887 to 1890, geologist for the state of Wyoming; and from 1890 to 1906, consulting engineer for Phelps Dodge and Company. Later he served as consulting engineer and director of different copper companies. Dr. Ricketts was the author of several books on mining and of numerous technical articles.

JOSÉ RAMON VILLALON (Assoc. M. '95) of Havana, Cuba, died there in September 1938, though word of his death has just reached Society Headquarters. Mr. Villalon, long a life member of the Society, was 74.

FRANK BATES WALKER (M. '23) consulting engineer for the Eastern Massachusetts Street Railway Company, Boston, Mass., died suddenly at his home in that city on June 3, 1940. Mr. Walker, who was 65, had been with the Eastern Massachusetts Street Railway Company since 1913—for many years as chief engineer. Before that (1898 to 1913) he was with the Great Northern Railway. During the war he served the government as material engineer at the Boston Army Supply Base.

RAYMOND F. WALTER (M. '09) chief engineer of the U.S. Bureau of Reclamation, at Denver, Colo., died in Fresno, Calif., on June 30, 1940, at the age of 66. From 1894 to 1904 Mr. Walter was a junior partner in the engineering firm of E. E. Baker and Walter. He was with the Bureau of Reclamation (then the U.S. Reclamation Service) from 1902 on, serving successively as supervising engineer of the Rocky Mountain Division, senior engineer in charge of the Rio Grande Project; assistant chief of construction; and (since 1925) chief engineer at Denver. In the latter capacity Mr. Walter directed work on Boulder Dam, the Columbia Basin Project, Grand Coulee Dam, and numerous other noted projects.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From June 10 to July 9, 1940, Inclusive

ADDITIONS TO MEMBERSHIP

ALLEN, LLOYD, JR. (Assoc. M. '40), With Dept. of Water and Power, 207 South Broadway (Res., 501 North Lucerne Blvd.), Los Angeles, Calif.

ASSICURATO, THOMAS (Jun. '40), Stress Analyst, Curtiss Aeroplane Div. (Res., 51 Villa Ave.), Buffalo, N.Y.

BANKHEAD, JOSEPH HARDING (Assoc. M. '40), Senior Engr., State Road Comm., 1307 Fifth, Moundsville, W.Va.

BOEMI, ANTHONY ANDREW (Jun. '40), Research Asst., Dept. of City Planning, Municipal Bldg., New York, N.Y.

BOURNOFF, NICHOLAS (Assoc. M. '39), Care, Fred T. Ley & Co., Ltd., Apartado 1529, Lima, Peru.

BRINCKERHOFF, HENRY MORTON (M. '40), 142 Maiden Lane, New York, N.Y.

CARMAN, SIMON PETER (M. '40), Deputy City Engr., Municipal Bldg. (Res., 22 Johnson Ave.), Binghamton, N.Y.

CLAY, EDWARD PHILLIPS (Jun. '39), Insp., State Road Comm., State Capitol Bldg., Salt Lake City, Utah.

CROW, STEVEN GLENBURN (Jun. '40), Junior Engr., U.S. Bureau of Reclamation, Redding, Calif.

DALTON, ROBERT PIERCE (Jun. '39), With the Austin Co., 3436 Superior Park Drive, Cleveland Heights, Ohio.

DARBAKER, ARTHUR KINNARD (Assoc. M. '40), Civ. Engr., Carnegie-Illinois Steel Co., Irvin Works, Dravosburg (Res., 807 Van Kirk St., Clairton), Pa.

DEARDORFF, HERBERT HADLEY (Assoc. M. '40), Junior Highway Engr., State Div. of Highways, 2001 Van Ness, San Francisco (Res., 728 Sixth St., Petaluma), Calif.

DEBARDELEBEN, JAMES MITCHELL (Assoc. M. '40), Associate Highway Engr., U.S. Public Roads Administration, 518 Federal Bldg., Little Rock, Ark.

DICKSON, HUGH CLINT (Assoc. M. '40), Cons. Engr., Box 1121, El Paso, Tex.

ELLIOTT, EDWIN ASHLEY (Assoc. M. '40), Civ. Engr., Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo.

ENEY, WILLIAM JOSEPH (Assoc. M. '40), Asst. Prof., Civ., Eng., Lehigh Univ., 106 Packer Hall, Bethlehem, Pa.

FISHER, RALPH LASHER (Assoc. M. '40), Senior Designer, Pennsylvania Turnpike Comm., 11 North 4th St., Harrisburg, Pa.

FLANAGAN, JAMES FRANCIS (Assoc. M. '40), Civ. Engr., California Fruit Exchange, Graeagle, Calif.

FORD, DWAYAIN KEENE (Jun. '40), Senior Eng. Aide, U.S. Engr. Dept., 700 Central Bldg., Seattle, Wash.

GALLIMORE, CLARENCE LEROY (Assoc. M. '40), Engr. (Civ.), Ohio River Div. Office, U.S. Engrs., 1420 Enquirer Bldg., Cincinnati, Ohio.

GARDNER, LYLE BURDETTE (M. '40), Supt., E. J. Albrecht Co., 2632 West 26th St., Chicago (Res., 315 Bartram Rd., Riverside), Ill.

GUDEN, RICHARD MORTIMER (Jun. '40), Insp. of Constr., Public Works, U.S. Navy, Navy Yard, Brooklyn (Res., 27 Watts Pl., Lynbrook), N.Y.

HANSON, IVAN PHILIP (Assoc. M. '40), Res. Engr., Ash-Howard-Needles & Tammen, Box 125 (Res., 503 South Union), Natchez, Miss.

HAY, JOHN LEONARD (Assoc. M. '40), Engr., New Mexico Power Co., Santa Fe, N.Mex.

HERSUM, LEROY MAXWELL (M. '40), Cons. Engr., 6 Beacon St., Boston, Mass.

IRVIN, WILLIAM PAUL (Assoc. M. '40), Supt., WPA, Project 501, National Bureau of Standards (Res., 1824 Belmont Rd., N.W.), Washington, D.C.

JOHNSON, RALPH JAMES (Jun. '39), 731 Linn St., Peoria, Ill.

JULIAO, VICTOR NELSON (Assoc. M. '40), Engr. of Canals, Highways and Ports, Malaria Div., National Palace, Panama.

JUNG, JOSEPH WILLIAM (Jun. '40), 70–06 Sixty-Ninth Pl., Glendale, N.Y.

KARLEN, ROY EDWIN (Jun. '40), Asst. Engr., U.S. Engrs., Federal Bldg. (Res., 2215 Glenmary Ave.), Louisville, Ky.

KEYAK, MICHAEL HENRY (Jun. '40), Junior Water Purifications Engr., San Francisco Water Dept., Millbrae, Calif.

KULIN, HARVEY JULIUS (Jun. '40), Sales Engr., The Am. Well Works, 20 North Wacker Drive, Chicago (Res., 3604 Prairie, Brookfield), Ill.

LAPPAS, FRANK GEORGE (Jun. '40), 2254 West Adams St., Chicago, Ill.

LEVITAN, PHILIP WOLF (Jun. '40), Recorder, Interior Dept., U.S. Geological Survey, 226 Post Office Bldg., Jamaica (Res., 611 West 148th St., New York), N.Y.

LINDBERG, HARRY EMIL (M. '40), Asst. Chf. Engr., Pittsburgh–Des Moines Steel Co., Neville Island (Res., 3833 Brighton Rd., N.S.), Pittsburgh, Pa.

LYON, GEORGE BERNARD (Jun. '40), Test Asst., Univ. of Illinois, Talbot Laboratory, Urbana (Res., 607 East Springfield Ave., Champaign), Ill.

MCDARGH, CHARLES DERBY (Assoc. M. '40), Supervisor, Eng. Review Unit, WPA, 429 North Pennsylvania (Res., 4485 Marcy Lane, Apt. 207), Indianapolis, Ind.

MCKINNEY, JAMES ROBERT (Jun. '40), Graduate Asst., Case School of Applied Science (Res., 14207 Coit Rd.), Cleveland, Ohio.

MCMORROW, BERNARD JAMES (Assoc. M. '40), San. Engr. and Health Officer, Board of Health, Territory of Hawaii, 37 Kekaulike, Hilo, Hawaii.

MADSEN, RUSSELL HYRUM (Jun. '40), Junior Engr., U.S. Bureau of Reclamation, Knight Block, Provo, Utah.

MASON, TROXELL OLIN (Jun. '40), Engr., Keeley Constr. Co., Empire Bank Bldg., Clarksburg, W.Va.

MEESE, RICHARD HUNT (Jun. '40), Junior Engr., Seattle Housing Authority Site Engrs., 1005 Lloyd Bldg. (Res., 4731 Twenty-First Ave., N.E.), Seattle, Wash.

MICHAEL, STANLEY AUSTIN (Jun. '39), Junior Engr., SCS, CCC-SCS 20, Hebron, Nebr.

MIRGAIN, FRANK CHARLES (Assoc. M. '40), Asst. Prof., Civ. Eng., Rutgers Univ., New Brunswick, N.J.

MOORE, RAYMOND LEWIS (Assoc. M. '40), Research Structural Engr., Aluminum Research Laboratories, Aluminum Co. of America, Box 772, New Kensington, Pa.

MORTENSEN, CARL JULIUS (Jun. '40), 3850 Clarke St., Oakland, Calif.

MUNGER, HARRIS BRENNER, JR. (Jun. '40), Asst. Eng. Aid, U.S. Eng. Dept. Box 792, Auburn (Res., 207 Virginia Ave., Modesto), Calif.

PETERSON, CARLYLE WILHELM (Jun. '40), Instr., Iowa State Coll., 201 Laboratory of Mechanics, Ames, Iowa.

PORTER, NORMAN (Jun. '40), Eng. Aide, Federal Power Comm., 18th and K Sts., N.W., Washington, D.C.

PRICE, HARRY STEELE, JR. (Assoc. M. '40), Secy., Price Bros. Co., Box 825, Dayton, Ohio.

PURDIE, DAVID JAMES, JR. (Jun. '40), With Parson, Klapp, Brinckerhoff & Douglas, 142 Maiden Lane, New York, N.Y. (Res., 75 Personette Ave., Verona, N.J.)

REESE, AUGUSTUS FRANKLIN, JR. (Jun. '40), Care, State Highway Dept., Shallowater, Tex.

RHODES, FORREST LEROY (Jun. '40), Inspection Engr., State Highway Dept., Carson City (Res., 612 La Rue Ave., Reno), Nev.

ROSS, JOHN FRANCIS (Jun. '40), Junior Civ. Engr., Humble Oil & Refining Co., 1210 Main St., Houston, Tex.

RUSSELL, ROCHESTER GEORGE (Jun. '39), With Carnegie-Illinois Steel Corp., Clairton Works (Res., 417 Caldwell Ave.), Clairton, Pa.

SCHECHET, MANUEL MARTIN (Jun. '40), Eng. Asst., Grade 3, Office, Borough Pres. of Manhattan, Municipal Bldg. (Res., 5000 Broadway), New York, N.Y.

SEIPT, HENRY MAXIMILLIAN, JR. (Jun. '40), Junior Engr., U.S. Bureau of Reclamation, Box 468, San Angelo, Tex.

STANLEY, JOSEPH ANDREW, JR. (Jun. '40), Junior Insp., State Highway Dept., Box 983, Pecos, Tex.

STEPHENS, JOHN FIKE (Jun. '40), Care, Turner Constr. Co., Furman & Doughty Sts., Brooklyn, N.Y.

STRASSER, WILLIAM CONRAD (Jun. '40), Asst. Engr., Wabash Ry. Co., Room 8, Wabash Depot, Moberly, Mo.

THOMAS, RICHARD GLEN (Jun. '40), Junior Highway Engr., Bureau of Highway Research, State Highway Dept., 126 East Ash, Springfield (Res., Mount Auburn), Ill.

THOMPSON, WILLIAM DONALD (Assoc. M. '40), Care, Black & Veatch, 4706 Broadway, Kansas City, Mo.

VAN HORN, EMERY LAMARTINE (Assoc. M. '40), Junior Engr., U.S. Engrs., War Dept., Security Mutual Bldg. (Res., 276 Conklin Ave.), Binghamton, N.Y.

WILSON, MAYBIN HOMES (M. '40), Maj. Corps of Engrs., U.S.A., West Virginia Univ. (Res., 253 Morris St.), Morgantown, W.Va.

WORMALD, FRANK (Jun. '40), Student Engr., U.S. Engrs., Buffalo Div., U.S. Engrs. Storehouse, Ft. of East 9th St., Cleveland, Ohio.

ZEIGLER, ROBERT RITCHIE (Assoc. M. '39), Civ. Eng., Frederick Snare Corp. 114 Liberty St., New York (Res., 37–05 Seventy-Ninth St., Jackson Heights), N.Y.

MEMBERSHIP TRANSFERS

ACKERMAN, ADOLPH JOHN (Jun. '26; Assoc. M. '31; M. '40), Director of Eng., Dravo Corp., Neville Island, Pittsburgh, Pa.

ADAMS, LAWRENCE FREDRIC (Jun. '33; Assoc. M. '40), Asst. Engr. Designer, Board of Water Supply, 346 Broadway, New York (Res., 70 Katan Ave., Staten Island), N.Y.

BIRKELAND, HALVARD WESSEL (Jun. '32; Assoc. M. '39), Asst. Engr., The Panama Canal, Box 377, Balboa Heights, Canal Zone.

BRUTON, PHILIP GILSTRAP (Jun. '18; Assoc. M. '20; M. '40), Maj., Corps of Engrs., U.S.A., 540 Federal Bldg., Buffalo, N.Y.

DEVAUL, WILLARD ROGERS (Jun. '24; Assoc. M. '28; M. '40), Pres., S. E. Minor & Co., Inc., Room 31, Smith Bldg. (Res., 7 Osceola Drive), Greenwich, Conn.

DOAK, JOHN (Assoc. M. '35; M. '40), Supt. of Buildings, Physical Plant Dept., Univ. of Illinois, 110 Power Plant, Urbana, Ill.

DORRANCE, WILLIAM TULLY, JR. (Jun. '32; Assoc. M. '40), Senior Eng. Aid, State Highway Dept., 165 Capitol Ave., Hartford (Res., 2918 Main St., Glastonbury), Conn.

TOTAL MEMBERSHIP AS OF JULY 9, 1940	
Members	5,658
Associate Members	6,496
Corporate Members	12,154
Honorary Members	31
Juniors	4,234
Affiliates	71
Fellows	1
Total	16,491

ELDER, CLAYBURN COMBES (Assoc. M. '26; M. '40), Hydrographic Engr., Met. Water Dist. of Southern California, 306 West 3d St., Room 1009, Los Angeles, Calif.

ENDRESS, STEPHEN GARDNER (Jun. '29; Assoc. M. '40), Office and Field Engr., Freese and Nichols, 407 Capps Bldg. (Res., 4001 Collinwood St.), Forth Worth, Tex.

GILBERT, JOSEPH JENKINS (Jun. '30; Assoc. M. '40), San. Engr., Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia (Res., 201 Wheatsheaf Lane, Abington), Pa.

HAWLEY, HARRY HOLMAN (Assoc. M. '36; M. '40), Project Engr., State Dept. of Highways (Res., 468 Laurel St.), Chillicothe, Ohio.

HOMER, LANGLEY STODDARD (Assoc. M. '20; M. '40), Supt. of Constr., Turner Constr. Co., 80 Newbury St., Boston, Mass.

KEIM, SAMUEL GEORGE (Jun. '32; Assoc. M. '40), Regional Office, National Park Service, Eng. Div., Santa Fe, N.Mex.

LANE, EDWARD NEIL WILTAMUTH (Jun. '37; Assoc. M. '40), Junior Civ. Engr., National Advisory Committee for Aeronautics, Langley Field, Hampton (Res., 218 South Willard Ave., Phoebus), Va.

LEWIN, HAROLD ANDREW (Jun. '35; Assoc. M. '40), Asst. Section Engr., Board of Water Supply, 749 Palmer Rd., Bronxville, N.Y.

MCCAIN, DEWEY MARVEN (Assoc. M. '28; M. '40), Head, Dept. Civ. Eng., Mississippi State College, State College, Miss.

MAGUIRE, CHARLES AUGUSTINE (Assoc. M. '34; M. '40), Cons. Engr., Charles A. Maguire & Associates, 603 Turks Head Bldg., Providence, R.I.

MILES, WALTER FRANK (Jun. '33; Assoc. M. '39), Office Mgr., Pacific Bridge Co., Box 1196 (Res., 4702 Pacific Ave.), Tacoma, Wash.

MINAMI, JOHN KAZUO (Jun. '32; Assoc. M. '40), Asst. Prof. Waseda Univ. (Res., 32 Edogawa Apartment, Shin-ogawa-machi, Ushigome), Tokyo, Japan.

NERDAHL, LOYAL MELVIN (Jun. '36; Assoc. M. '40), Maintenance Engr., Lake Mohonk Mountain House, Mohonk Lake, N.Y.

PANUZIO, FRANK LOUIS (Jun. '31; Assoc. M. '40), Associate Engr., U.S. Engr. Office, 39 Whitehall St., New York, N.Y. (Res., 1385 Capitol Ave., Bridgeport, Conn.)

PEARSON, EDWARD RUSSELL (Jun. '34; Assoc. M. '40), Asst. Engr., U.S. Engr. Office, Galveston, Tex.

PETTIT, HOMER BANISTER (Jun. '20; Assoc. M. '23; M. '40), Maj., Corps of Engrs., U.S.A., War Dept., 605 Federal Bldg., Detroit, Mich.

PRAY, CECIL (Jun. '32; Assoc. M. '39), Field Engr., State Highway Dept., Div. Office (Res., 2213 Talunar Lane), Wichita Falls, Tex.

RIDGE, SYLVESTER EDWIN (Jun. '31; Assoc. M. '40), Dist. Engr. Bituminous Service Co., Highland, N.Y.

RUSSELL, WALTER CLAIR (Assoc. M. '22; M. '40), Vice-Pres. and Gen. Mgr., Peerless Cement Corp., 1144 Free Press Bldg., Detroit, Mich.

SMRHA, ROBERT VACLAV (Jun. '29; Assoc. M. '39), Senior Engr., Hydrology and Hydr. Structures, Div. of Water Resources, State Board of Agriculture, State House, Topeka, Kans.

SNYDER, HAROLD JOHN (Jun. '28; Assoc. M. '40), Asst. Engr., J. Paul Blundon, 81 Orchard St. (Res., 37 Maple Ave.), Keyser, W.Va.

SWIECH, PAUL CHARLES (Jun. '35; Assoc. M. '40), Engr., Holt Constr. Co., 3830 Brownsville Rd., Brentwood (Res., 115 Seventh Ave., Carnegie), Pa.

TANNER, BURFORD MAURICE (Jun. '38; Assoc. M. '40), Asst. Hydr. Engr., U.S. Forest Service, Glendora, Calif.

TAUSSIG, JOHN WRIGHT (Jun. '15; Assoc. M. '17; M. '40), Vice-Pres. and Director, Raymond Concrete Pile Co., 140 Cedar St., New York, N.Y.

VAUGHAN, HENRY FRIEZE (Jun. '16; Assoc. M. '19; M. '40), Commr. of Health, Detroit Dept. of Health, 3919 John R. St., Detroit, Mich.

ZIMMERMAN, OSCAR AMBROSE (Assoc. M. '12; M. '40), Cont. and Constr. Engr., Massman Constr. Co., 737 New York Life Bldg. (Res., 3740 Benton Blvd.), Kansas City, Mo.

REINSTATEMENTS

DIEHL, DAVID LESLIE, Assoc. M., reinstated July 8, 1940.

LEWIS, EDWARD ROWLAND, M., reinstated June 17, 1940.

PARK, RICHARD, M., reinstated June 10, 1940.

RESIGNATIONS

KOCH, JOHN POPE, Jun., resigned June 11, 1940.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

August 1, 1940 NUMBER 8

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

BESHERS, HUGH MONAHAN, Aruba, N.W.I. (Age 40) (Claims RC 12.1 D 5.3) July 1929 to date with Aruba (N.W.I.) Refinery, as Asst. Gen. Supt., Pan American Petroleum and Transport Co., Asst. Gen. Supt., and (since Jan. 1936) Div. Supt., Lago Oil & Transport Co., Ltd.

BOYLES, RICHARD HAMILTON, Pittsburgh, Pa. (Age 38) (Claims RC 11.0 D 3.5) March 1937 to date Borough Mgr., Fox Chapel Borough; previously Field Representative, Construction Association of Western Pennsylvania; Engr., Allegheny County Planning Comm.

COLEMAN, JAMES HEARST, Greenwood, S.C. (Age 43) (Claims RCA 1.3 RCM 11.6) Aug. 1932 to date Consultant (private), and City Engr.

CSANYI, LADIS HENRY (Assoc. M.), Jamaica, N.Y. (Age 37) (Claims RCA 3.1 RCM 9.5) July 1938 to date with Dept. of Borough Works, Manhattan, since July 1939 as Asst. Engr., Grade 4; previously Eng. Asst., Dept. of Public Works, Manhattan.

DAVIES, JOSEPH HERBERT, Long Beach, Calif. (Age 37) (Claims RCA 4.0 RCM 9.5) Sept. 1933 to date Cons. Engr. (private practice).

DLOUHY, FRANCIS NILS, Los Angeles, Calif. (Age 37) (Claims RCA 2.5 RCM 12.9) Feb. 1925 to Jan. 1927 and June 1929 to date (except 1932 on scientific research) in private practice as Civ. and Structural Engr.

FABER, BENNIE HERMAN, Eagle Lake, Tex. (Age 46) (Claims RCA 1.7 RCM 18.2) July 1939 to date in private practice; previously Surveyman (Party Chf.), Flood Control Survey of Trinity River by U.S. Engrs.; Field Engr., Lower Colorado River Authority, Austin; Engr. Inspector, PWA, Fort Worth.

GARDNER, FRANK HENRY, Bridgeport, Ala. (Age 43) (Claims RCA 6.5 RCM 14.5) March 1940 to date Staff Engr., FWA, WPA of Alabama; previously Res. Engr., Contract 1–7 Mobile (Ala.) Vehicular Tunnel; Associate Engr., FEA of PW; Engr., Georgia State Highway Dept.; Inspection Engr., TVA; Project Engr., Florida State Road Dept.

HOLLAND, PAUL, Detroit, Mich. (Age 45) (Claims RCA 7.5 RCM 10.0) Nov. 1919 to date with Wayne County Road Commrs., Detroit, Mich., as Instrumentman, Party Chf., and (since Nov. 1922) Asst. Road Engr. in charge of Road Drafting Dept.

KORTE, JOSEPH CLARENCE, Somerset, Pa. (Age 44) (Claims RC 8.8 D 1.3) April 1939 to date Res. Engr., Pennsylvania Turnpike; previously Bridge Inspector, Virginian Ry.; Asst. Supt., Vang Constr. Co., Pittsburgh, Pa.; Rodman, Levelman, Transitman, and Asst. Concrete Inspector, Baltimore & Ohio R.R.

LIDDLE, FREDERICK WILLIAM, Wyandotte, Mich. (Age 51) (Claims RCA 2.0 RCM 28.5) 1934 to date City Engr.

MURPHY, RAYMOND WILLIS (Assoc. M.), Billings, Mont. (Age 37) (Claims RCA 2.0 RCM 12.4) Aug. 1936 to Nov. 1938 Associate Engr., and Nov. 1938 to date Engr., U.S. Indian Service; previously Project Mgr. on construction, Ute Indian Reservation, Colorado, and Pine Ridge Reservation, South Dakota.

NIVEN, FRANCIS JOSEPH, Houston, Tex. (Age 41) (Claims RCM 15.0) 1932 to date Cons. Engr. (private practice).

SMITH, GEORGE ERNEST, New Milford, Conn. (Age 62) (Claims RCM 29.6) Aug. 1910 to date with Connecticut State Highway Dept., as Div. Engr., and (since April 1932) Engr. of Location.

SUBRAHMANYAN, KUPPUSWAMI, Colombo, Ceylon. (Age 39) (Claims RC 6.0 D 9.3) Sept. 1939 to June 1940 graduate student, Harvard Univ.; previously Asst. Engr., Div. of San. Eng., Dept. of Medical and Sanitary Services, Ceylon.

SWATOSH, WENDELL ROBERT, Cleveland Heights, Ohio. (Age 45) (Claims RCM 21.5) Feb. 1916 to date with Erie R.R. Co., successively as Rodman, Levelman, Draftsman, Instrumentman, Transitman, Res. Engr., and (since May 1925) Asst. Engr.

VAN BUSKIRK, PAUL, Detroit, Mich. (Age 47) (Claims RCA 8.1 RCM 10.5) Jan. 1934 to date Engr., Board of County Auditors, Wayne County, Mich.

APPLYING FOR ASSOCIATE MEMBER

BERRY, RALPH MOORE, Kensington, Md. (Age 30) (Claims RCA 2.7 RCM 1.0) Sept. 1938 to date Chf., Surveys Div., Maryland-National Capitol Park and Plan Comm., Silver Spring, Md.; previously Civ. Engr., Montgomery County Surveyor's Office; Field Engr., Continental Life Insurance Co., Washington, D.C.; Transitman, and Civ. Engr., Resettlement Administration.

CAPLING, LEONARD (Junior), Forest Hills, N.Y. (Age 32) (Claims RCA 1.0) Oct. 1937 to date Designing Engr., Ambursen Eng. Corporation, New York City; previously Structural Designer, Corn Products Refining Co.; Concrete Inspector, All American Canal Project, Bureau of Reclamation, Yuma, Ariz.; Structural Designer, The Panama Canal, Sec. of Office Engr.

COWEN, CHESTER MELCENIA (Junior), Chickasha, Okla. (Age 32) (Claims RCA 4.7) Feb. to May 1934, Aug. to Dec. 1936, Jan. to Oct. 1938, and Jan. 1939 to Jan. 1940 Supt. on Construction with Chester Cowen, Contr.

CRAWFORD, LEONARD KENNETH (Junior), Springfield, Ill. (Age 27) (Claims RCA 2.5 RCM 0.5) June 1937 to date Engr. with Wood, Walraven & Tilly (now Walraven & Tilly), Engrs.; previously student; Eng. Aide, Bureau of Biological Survey, Minot, N.Dak.

DARBY, MITCHELL, Houston, Tex. (Age 31) (Claims RCA 8.0) 1938 to date Pres., Mitchell Darby, Inc., Gen. Contrs. and Engrs.; previously with Brown & Root, Inc., Austin, Tex., and with R. W. Briggs & Co., Pharr, Tex.

DECKER, SHERMAN OLIVER, Yuma, Ariz. (Age 32) (Claims RCA 2.2) Feb. 1935 to Feb. 1940 Jun. Hydr. Engr., March to May 1940 Res. Engr., and May 1940 to date Asst. Hydr. Engr., Water Resources Branch, U.S. Geological Survey.

GEUSS, ARTHUR PAUL (Junior), Charleston, S.C. (Age 30) (Claims RCA 3.0) Jan. 1936 to Jan. 1937, and Oct. 1937 to date with Harza Eng. Co., as Designer, Detailer, etc., and (since Sept. 1938) Designer and Squad Boss.

GREENE, KENNETH JOHN, Boulder, Colo. (Age 32) (Claims RC 4.8) Sept. 1939 to June 1940 student, Univ. of Colo.; previously Jun. Topographical Engr., Conservation Branch, U.S. Geological Survey; Draftsman, U.S. Forest Service; Instrumentman, and Draftsman, New Mexico Eng. Co.

HARTIG, FRANZ JOHN (Junior), Baltimore, Md. (Age 30) (Claims RCA 6.1) April 1935 to date Eng. Aide, Chemical Warfare Service, War Dept., U.S. Govt., Edgewood Arsenal, Md.

HEARD, WILLIAM LEE (Junior), New Albany, Miss. (Age 32) (Claims RCA 7.6 RCM 0.8) July 1935 to date with SCS, as Dist. Supervisor, ECW, Dist. Engr., CCC, Project Engr., and (since Feb. 1939) Area Engr.; previously Eng. Foreman, CCC Camp, Mississippi Forest Service.

HERTEL, RAYMOND ERNEST (Junior), Chicago, Ill. (Age 31) (Claims RCA 2.5) June 1930 to date with U.S. Bureau of Public Roads (PRA) as Jun. Highway Engr., Asst. Highway Engr., and (since Jan. 1938) Associate Highway Engr.

HICKS, WILLIAM DELBERT, Cleveland, Ohio. (Age 41) (Claims RCA 3.8) Feb. 1927 to date with Erie R.R. Co., on grade-crossing elimination, etc.

IVY, RAYMOND JENNINGS (Junior), Sacramento, Calif. (Age 32) (Claims RCA 4.5) May 1931 to date with Bridge Dept., California Highway Dept., as Jun. Field Aide, Senior Field Aide, Jun. Bridge Engr., and (since Aug. 1938) Asst. Bridge Engr.

JOHNS, EDWARD ALLAN (Junior), Balboa, Canal Zone. (Age 32) (Claims RCA 2.8) April 1940 to date Asst. Engr., The Panama Canal; previously Jun. Engr., TVA; Eng. Draftsman, U.S. Engr. Office, Mobile, Ala.; Lightkeeper and Recorder, U.S. Dept. of Commerce and U.S. Coast & Geodetic Survey.

JOHNSON, GORDON HERVEY, Denver, Colo. (Age 32) (Claims RC 2.4) Nov. 1937 to date Jun. Engr., U.S. Bureau of Reclamation; previously Res. Engr., WPA; Field Engr., FERA.

KAYSEN, JAMES PHILO, Cedarburg, Wis. (Age 29) (Claims RCA 2.2) Sept. 1928 to Sept. 1929 and Aug. 1936 to date with Chicago, Mil-

waukee, St. Paul & Pacific R.R. Co., Milwaukee, Wis., as Tapeman, Rodman, Instrumentman, and (since Feb. 1937) Special Engr., Signal Dept.; in the interim Instructor in Ry. Eng., Univ. of Wisconsin; Camp Engr., ECW.

KETCHUM, SMITH ADRON, (Junior), Redding, Calif. (Age 32) (Claims RCA 2.5) Sept. 1933 to date with U.S. Bureau of Reclamation as Jun. Engr., Earth Dams Sec., and (since Sept. 1936) Asst. Engr.

KUYKENDALL, AUBREY LEON (Junior), Brooklyn, N.Y. (Age 32) (Claims RCA 5.5) Sept. 1939 to date Lieut. (jg), CEC-V(S), U.S.N.R.; previously Constr. Supt. with Ben Sira & Co. (2 years), and W. H. Warfield, Contr. (2 months); Engr.-Inspector, Powell & Powell, Engrs., Dallas; with C. A. & J. W. Vilbig, Jr., Contrs., Dallas.

MARIO DIEZ, RICARDO, Panama City, Panama. (Age 42) (Claims RC 10.3 D 10.4) May 1930 to Dec. 1933 and Aug. 1934 to date with Panama Govt., as Asst. Engr., Engr., and (since June 1936) Asst. to Chf. Engr.; also, since Jan. 1940 Engr., Dept. of Constr. Q.M., U.S. Army, Canal Zone, at present suspended because of illness.

MARKEL, LYMAN ARTHUR, Los Angeles, Calif. (Age 41) (Claims RCA 8.8 RCM 7.3) Jan. to Dec. 1936 Asst. Engr., and Dec. 1936 to date Associate Engr., U.S. Engr. Office; previously Sales Engr., Southwest Welding and Mfg. Co., Alhambra, Calif.

MISCH, FRANZ MARTIN (Junior), Redding, Calif. (Age 32) (Claims RCA 6.9) April 1929 to Sept. 1931 and April 1936 to date with Southern Pacific Co., as Engr. Inspector, Asst. Bridge and Bldg. Supervisor, etc., and (since Feb. 1939) Head Inspector on Redding to Delta relocation.

MORANG, CLARENCE NOLAN (Junior), Philadelphia, Pa. (Age 32) (Claims RCA 5.4) March 1940 to date Associate Engr., Forest Service, Dept. of Agriculture; Jan. 1930 to March 1940 with U.S. Engr. Office as Jun. Engr. and Asst. Engr., at various places.

NAUMAN, ARTHUR CHARLES (Junior), Camp Custer, Mich. (Age 30) (Claims RCA 3.8) March 1934 to Jan. 1936 and Jan. 1937 to date with CCC as 2d Lieut., Dist. Constr. Officer and Motor Transportation Officer, and (since Sept. 1939) Constr. Engr.

ODELL, JOHN WALTER, St. Louis, Mo. (Age 32) (Claims RCA 3.9 RCM 0.5) May 1935 to date with U.S. Geological Survey as Jun. Hydr. Engr., and (since Feb. 1939) Asst. Hydr. Engr.

ROSE, HOWARD DEWITT, Grahamsville, N.Y. (Age 34) (Claims RCA 3.4) May 1931 to July 1932 and Feb. 1937 to date with New York City Board of Water Supply as Eng. Inspector, Asst. Engr., and (since Aug. 1939) Asst. Sec. Engr.

SEALE, ALLEN THOMAS FRANKLIN, Lufkin, Tex. (Age 33) (Claims RCA 3.9) Sept. 1929 to Feb. 1939 and June 1940 to date with Texas Highway Dept., as Rodman, Concrete Inspector, Instrumentman, Bridge Inspector, Asst. Res. Engr., Jun. Res. Engr., and (since June 1940) Res. Engr.

SOMMA, GEORGE EDWARD (Junior), White Plains, N.Y. (Age 32) (Claims RCA 1.5) July 1937 to Jan. 1938 Engr., and March 1938 to date Structural Designer, Madigan & Hyland, Cons. Engrs.; previously Eng. Asst., U.S. War Dept. and N.Y. State Div. of Highways.

TREECE, CLYDE CHARLES (Junior), Little Rock, Ark. (Age 32) (Claims RCA 7.0) Sept. 1938 to date Designer, Arkansas State Highway Dept.; Aug. to Sept. 1938 Engr., City of Stamps, Ark.; Jan. 1937 to Aug. 1938 Fieldman, Phoenix Eng. Corporation, New York City; previously graduate student, Univ. of Arkansas.

UITTI, WILLIAM LEOPOLD (Junior), Chicago, Ill. (Age 32) (Claims RCA 6.3) June 1939 to date Structural Steel Inspector and Engr., Chicago (Ill.) Rapid Transit Co.; previously Field Engr. and Asst. Supt. in charge of projects, Bureau of Park Recreation and Aviation (WPA) Chicago, Ill.; Industrial Hygiene Field Engr., Illinois State Dept. of Health; Estimator and Sales Engr., Home Owners' Improvement Co.; 1st Lieut., Engr. Reserve Corps, U.S. Army.

WHITE, EDWARD EMELIN (Junior), New York City. (Age 31) (Claims RCA 3.6 RCM 1.6) Jan. 1933–May 1935 and Sept. 1936 to date with Spencer, White & Prentis, Inc., as Jun. Engr., Draftsman, Field Engr., Office Engr., Designer, Field Supt., and (since Dec. 1939) Estimator and Engr.

WRENN, LEWIS MITCHELL, Pontiac, Mich. (Age 48) (Claims RCA 5.3 RCM 9.0) 1932 to date with City of Pontiac, Mich., as City Engr., Director of Public Works and Asst. City Mgr.

APPLYING FOR JUNIOR

DEWART, DONALD MACLEAN, Buffalo, N.Y. (Age 24) 1938 B.S. in C.E., Univ. of Vt.; June 1940 to date Student Engr. (Civ.), U.S. Engr. Office; previously Eng. Aide, Federal Power Comm.

FARRAR, ROGER MACY, Caripito, Venezuela. (Age 28) (Claims RCA 3.5) April 1939 to date Civ. Engr., Standard Oil Co. of New Jersey, San Joaquin Dist.; previously Jun. Airport Engr., Civil Aeronautics Authority; Town Engr., Wrentham, Mass.

GRAHAM, JACKSON, Cambridge, Mass. (Age 25) (Claims RC 2.7 D 0.7) July 1936 to date with Corps of Engrs., U.S. Army, War Dept., as 2d Lieut., and (since Sept. 1939) 1st Lieut., also graduate student, Massachusetts Inst. of Technology.

HEURICH, ROBERT PAUL, Pittsburgh, Pa. (Age 22) 1939 B.C.E., Rens. Pol. Inst.; Nov. 1939 to date Jun. Engr., U.S. Engr. Dept.

MATHEU, ROBERT RICHARD, San Francisco, Calif. (Age 27) June 1939 to date Structural, Draftsman, Hall and Pregnogg, Cons. Engrs.; previously Field Engr., George Wagner Co., San Francisco, Calif.

RIGSBEE, HERBERT KENNETH, Austin, Tex. (Age 29) 1940 B.S. in Civ. Eng., Univ. of Tex.; April 1934 to July 1935 with State Parks Board, U.S. Govt.; July 1936–Sept. 1937 Project Supt., WPA.

SCHIPKE, JOHN HENRY, JR., St. Paul, Minn. (Age 27) Oct. 1939 to date Teaching Asst. and graduate student, Univ. of Minnesota; previously with Bureau of Public Roads (PRA) as student Highway Engr. and Jun. Highway Engr.; Engr., and Draftsman, South Dakota State Highway Dept.

SMITH, EDWARD GERALD, Denison, Tex. (Age 23) Sept. 1938 to date 2d Lieut., Corps of Engrs., War Dept., U.S. Army; previously Instructor in Surveying, Lehigh Univ.

TURNER, MORTIMER MURRAH, JR., Kansas City, Mo. (Age 24) Sept. 1938 to Nov. 1939 Jun. Eng. Aide, U.S. Bureau of Public Roads; Nov. 1939 to date Jun. Civ. Engr., U.S. Engr. Office.

1940 GRADUATES

UNIV. OF AKRON
(B.C.E.)

	AGE
LANTZ, ERSEL GLEN	(22)
PERRY, THOMAS HENRY, JR.	(26)

UNIV. OF ALA.
(B.S. in C.E.)

MORRIS, ROBERT EARL	(21)

UNIV. OF ARK.
(B.S.C.E.)

HALL, RICHARD VERNON	(22)

ARMOUR INST. TECH.
(B.S. in C.E.)

BALSEWICZ, JOHN CHARLES	(26)
ELGENSON, LEONARD	(21)
HANNA, GEORGE PARKER, JR.	(22)

BROOKLYN POLY. INST.
(B.C.E.)

CARL, KENNETH JOHN	(27)
CUMMINGS, ROBERT HOWARD	(20)
SUSSMAN, GABRIEL	(22)

BUCKNELL UNIV.
(B.S. in C.E.)

DRUMM, DONALD LARUE	(27)
EYER, CHARLES ROHLAND	(23)
MCKELVEY, HAROLD EDWARD	(21)
MILLARD, CHARLES FREDERICK	(22)
YARNALL, WAYNE BROWN	(22)

CALIF. INST. TECH.
(B.S. in Eng.)

GEWE, ROBERT ALEXANDER	(22)

(M.S. in Civ. Eng.)

OLSSON, JUSTUS AXEL	(26)
(Also 1935 B.S., Univ. of Calif.)	

CARNEGIE INST. TECH.
(B.S. in Civ. Eng.)

AUSTIN, CLEMONT ROBERT, JR.	(22)
DIXON, WILLIAM JAMES	(21)
ELDER, REX ALFRED	(22)
HIRSCH, HAROLD	(23)
RALSTON, THOMAS EUGENE	(21)

UNIV. OF CIN.
(C.E.)

AGOSTINI, BRUNO CHARLES	(25)
ALLEN, EDWIN HOWE, JR.	(25)
KLARER, DAVID	(24)
SHARKEY, THOMAS BERNARD	(22)
STEFFENS, LOUIS ARTHUR	(24)

CLEMSON COLL.
(B.C.E.)

ABLE, THOMAS ANDREW, JR.	(21)
GILLESPIE, RAYMOND MILLER	(21)
PHILLIPS, JAMES VERNON, JR.	(21)

UNIV. OF COLO.
(B.S. in A.E.)

BARNES, CLARA MAYBELLE (MISS)	(21)
HANKS, GEORGE FREDERICK	(23)
PETERSEN, THEODORE DENHAM	(22)

(B.S. in C.E.)

BUIRGY, THEODORE FRANCIS	(25)
DREIER, DOUGLAS EMERIT	(20)
DRESCHER, WILLIAM JAMES	(21)
HOUK, IVAN EDGAR, JR.	(25)
REEVES, WILLIAM QUIGGLE	(23)

COOPER UNION
(B.S. in C.E.)

AQUINO, MICHAEL THOMAS, JR.	(27)
BOUDON, PLACER	(22)
CALIGIURI, EDWARD	(22)
CENTER, BERNARD MELIN	(25)
FALKIN, MURRAY	(20)
FEGAN, JOSEPH CLIFFORD	(23)
FOX, GEORGE ARNOLD	(20)
FRASCELLA, THOMAS JOHN	(26)
GLASER, AUGUST JOHN	(22)
GLASS, MAX	(27)
HANFT, JOHN DANIEL	(21)
KOROSHETZ, WALTER THOMAS	(22)
LINSKY, HORACE	(20)
PEREZ, HENRY TAYLOR	(25)
POHLE, FREDERICK VALENTINE	(21)
ROLLY, GEORGE PHILIP	(23)
SKIBA, JOHN	(20)
SOMSON, ALFRED SPENCER	(24)
STONE, WILLIAM LIVINGSTON, JR.	(22)
STRAUSS, MAX WILLIAM	(25)
WEITZ, SAUL	(20)
ZUCKERMAN, MORRIS	(27)

UNIV. OF DAYTON
(B.C.E.)

FORSTHOFF, JOSEPH ROBERT	(22)
HILL, WILLIAM CLYDE	(20)
SMITH, RICHARD KENNETH	(22)
SULTENFUSS, JOHN HERMAN	(21)

UNIV. OF DEL.
(B.C.E.)

MAXWELL, JOSEPH RUSSELL	(22)
PLOTTS, JOSEPH EDWARD, JR.	(23)

DUKE UNIV.
(B.S. in C.E.)

GROESBECK, WILLIAM FRANCIS	(24)
MACLAUCHLAN, JOHN DONALD, JR.	(23)
MITCHELL, PHIL, II	(22)

UNIV. OF FLA.
(B.C.E.)

BURNETT, JOHN HUGH	(23)
CARTER, DOUGLAS MARTIN	(21)
COWDEN, BURNEY BEAUCHAMP	(25)
ELLIS, RICHARD BOURNE	(21)
KIRBY, WICKLIFFE BOULWARE	(23)
LASSITER, CHARLES BEERS	(23)
ROBERTS, CLYDE JEFFERSON	(25)
SHIVLER, JAMES FLETCHER, JR.	(22)
(B.C.E., 1938, and M.S.E. 1940)	

GA. SCHOOL TECH.
(B.S. in C.E.)

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(Also 1939 B.S., Northeastern Univ.)	
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(Also 1937 B.S. in C.E., Univ. of Hongkong)	

(M.S. in San. Eng.)

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(Also 1938 B.S.C.E., Univ. of Fla.)	

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ERDLE, JOHN FRANCIS	(28)

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(B.S.)

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(S.B.)

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(S.M.)

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(B.C.E.)

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DE SESSA, DANIEL ANTHONY (22)

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SEWELL, HAROLD EDWIN (29)
(Also 1934 B.S. in C.E., Okla. A. & M. Coll.)
TEWINKEL, GARRETT CARPER (31)
(Also 1932 B.S. in Mech. Eng., State Coll. of Wash.)

AGRI. & MECH. COLL. OF TEX.
(B.S. in C.E.)

THOMPSON, STERLIN NYLES (24)

(M.S. in C.E.)

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(Also 1939 B.S., Colo. State Coll.)

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PROCK, GEORGE DOYLE (27)
RIGSBEE, HERBERT KENNETH (29)
THOMPSON, CHARLES EVERETT (25)
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ROBERTS, ELBERT (25)
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SONNICHSEN, JOHN CHRISTIAN (22)
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BURKMAN, GRANT ARTHUR (22)
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DAHL, ARVE HUBERT (23)
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GOEKE, ROSCOE HENRY (22)
GRAVES, DOUGLAS EVENSEN (22)
HAMMER, VERNON BENJAMIN (21)
HANSEN, ARNOLD MELVIN (22)
HANSEN, ROBERT JOSEPH (22)
HOTES, FREDERICK LORRAINE (22)
KOLM, ROGER EDWARD (25)
LOCHOW, ROBERT HENRY (24)
LOCKETT, HAROLD BEN (21)
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MEISSNER, VERNON STEVEN (23)
NICHOLS, THOMAS ALEXANDER, JR. (26)
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The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

Items are furnished by the Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y. Address replies to key number, care of New York Office, unless Chicago or San Francisco office is designated. See page 132 of Society's 1940 Year Book for details of procedure.

CONSTRUCTION

BUILDING CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; 24 years graduate engineer on buildings; 14 years in charge of municipal building department; 45; registered engineer and surveyor in New York; laying out or supervision of construction; maintenance; building code work for municipalities or building material manufacturers. C-738.

ENGINEER; Jun. M. Am. Soc. C.E.; graduate mining engineer; 1 year in mining; 1 year U.S. Army, Corps of Engineers; 3 years surveying and general construction in South America; desires connection in United States in mining or civil engineering field or a combination of both fields. C-743.

CIVIL ENGINEER; Assoc. M. Soc. C.E.; 36; graduate; registered in Pennsylvania; superintendent and manager in charge of estimating and construction of roads, bridges, and heavy excavation. Desires permanent connection with contractor or consulting engineer; location immaterial. C-744.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 39; technical graduate; registered, state of Colorado. Wide experience on tunnel construction, rolled earth-fill dams, canals and waterways, administration, investigations, reports, and estimates. Municipal and general engineering fields. Wishes position with engineer, architect, or contractor. C-745.

EXECUTIVE

ENGINEER-EXECUTIVE; M. Am. Soc. C.E.; 51; married; B.S. in C.E.; 30 years experience; last 14 years in Buenos Aires, vice-president in responsible charge of large contracting company's branch operating over South America; fluent Spanish and thorough knowledge of business and financial conditions and commercial practices in use throughout Argentina, Chile, and Venezuela. C-746.

CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; 12 years responsible charge Latin-American projects; work included harbor improvements, pipe lines, oil storage, concrete and steel structures. Fluent knowledge of Spanish. Excellent credentials; available immediately. C-749.

JUNIOR

CIVIL ENGINEER; Jun. M. Am. Soc. C.E.; 25; single; B.S.C.E., North Dakota State College, 1939; degree with specialization in structures and sanitary design; general business experience; 1 year as 2d lieutenant, U.S. Army. Location immaterial; salary secondary to good opportunity. C-739.

CIVIL ENGINEER; Jun. M. Am. Soc. C.E.; 25; single; B.S. in C.E., New York University (credit toward M.C.E. in sanitary engineering); 1½ years drafting on sanitary and construction projects; 8 months field work in sanitation; desires permanent position. Employed, but available on short notice. C-740.

CIVIL ENGINEER; Jun. M. Am. Soc. C.E.; 23; married; B.S.C.E., Purdue University, 1939; three months in construction; 3 months in water supply maintenance; 7 months drafting. Steady position wanted; location immaterial; available on short notice to employer. C-741.

PLANT CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; married; graduate C.E.; registered professional engineer and surveyor, Ohio; 3 years assistant; 10 months chief civil engineer, large industrial plant; 8 months resident engineer in charge of construction of new building; estimating, design, layout, job control, maintenance of building and grounds. C-747.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; married; highway research board; University of Minnesota training; 3½ years superhighway, parkway design, and construction; one year municipal; 2½ years railroad and heavy construction. Location immaterial; available immediately. C-748.

TEACHING

ASSISTANT PROFESSOR; Jun. Am. Soc. C.E.; 29; M.S. in sanitary engineering; 3 years teaching sanitary engineering, public health, and miscellaneous civil engineering subjects; 4 years experience sanitary research, office practice, field investigations, reports and design in paving, water works, sewers, water and sewage plants; member professional and honorary societies; several publications. C-737.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 33; B.S. in C.E.; M.S. (geology); licensed professional engineer and land surveyor; 12 years professional experience in analysis, design, construction, administration; concurrent teaching experience in civil engineering department, evening division, metropolitan university; seeks position as engineer or assistant professor. C-742.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room will be found listed here. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

ELEMENTS OF STRENGTH OF MATERIALS, 2 ed. By S. Timoshenko and G. H. MacCullough. D. Van Nostrand Co., New York, 1940. 365 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $3.25.

The principal features of Timoshenko's two volumes, *The Strength of Materials*, are presented in abridged form as a textbook for undergraduates. In addition to a certain amount of revision, both in the text and the large number of problems, material has been added on welded joints, photoelasticity, and moments of inertia of plane areas.

ENGINEERING SURVEYS, rev. ed. By H. Rubey, G. E. Lommel, and M. W. Todd. Macmillan Co., New York, 1940. 321 pp., text; 141 pp., logarithmic and trigonometric tables. Illus., diagrs., charts, tables, maps, 8 × 5 in., leather, $3.50.

Written from the viewpoint of the modern engineer and executive, this book is a clear, concise presentation of the subject of plane surveying. It covers thoroughly the fundamentals of engineering surveys and explains the procurement and use of maps and data, the organization and costs of surveys, etc. The necessary tables are included, and a sample set of student field-notes has been appended to this revised edition.

PROBLEMS AND POLICIES IN INDUSTRIAL RELATIONS IN A WAR ECONOMY, rev. ed. A Selected, Annotated Bibliography. Prepared by H. Baker. Princeton University, Princeton, (N.J.), 1940. 30 pp., 9 × 6 in., paper, 25 cents.

The books, reports, and articles listed in this bibliography of industrial organization in war time cover conditions in the United States and Great Britain during the World War and the reconstruction period, legislative developments in the United States affecting current adjustment to a war economy, and discussions of current problems. There is an author index.

RAILROADIANS OF AMERICA, NEW YORK, Book No. 2, 1940. 76 pp., published by Railroadians of America, New York, Hawthorne, N.J., (56 Tuxedo Avenue). 76 pp., illus., charts, tables, maps, 11 × 8 in., paper, $2.

Number 2 of this series contains a history of the Sixth Avenue (New York) elevated line with contemporary illustrations, an article on the development and types of compound locomotives, and a history of the work and a description of the shops of Norris Brothers, locomotive builders, also with contemporary illustrations.

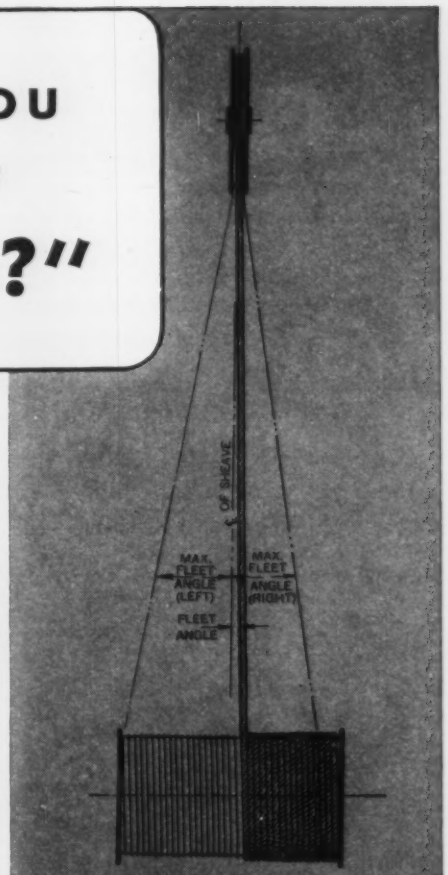
SOUND TRANSMISSION IN BUILDINGS, Practical Notes for Architects and Builders. By R. Fitzmaurice and W. Allen. Dept. of Scientific and Industrial Research, London, His Majesty's Stationery Office, 1940. 48 pp., illus., diagrs., charts, tables, 12½ × 9½ in., cloth, $1.20.

This volume is a practical report of investigations on sound transmission in buildings undertaken jointly by the National Physical Laboratory and the Building Research Station. The nature and transmission of sound are discussed, and proper construction for sound insulation purposes is described, with many detailed architectural drawings. There is a short bibliography.

STEAM POWER STATIONS, 2 ed. By G. A. Gaffert. McGraw-Hill Book Co., New York, 1940. 592 pp., illus., diagrs., charts, maps, tables, 9 × 6 in., cloth, $4.50.

This comprehensive and interesting volume on steam power-station work falls roughly into two sections. Chapters I–XVII deal with the construction and performance characteristics of the mechanical equipment, including fuels and feed water. The succeeding chapters cover plant economics and the integration of the machinery, with considerable discussion of steam and binary-vapor cycles. Problems and short bibliographies are included with the separate chapters.

"MR. OTT, HAVE YOU EVER HEARD OF FLEET ANGLE?"



USS

EXCELLAY *Preformed* WIRE ROPE

FROM THE DAILY REPORT
OF A TIGER BRAND
WIRE ROPE ENGINEER

Mr. Ott was burned up. "What kind of rope do you call that--practically new and yet it's all chewed up!"

It wasn't hard to see the trouble. The drum was too close to the lead sheave. When reeving on the ends of the drum, the rope rubbed hard against the sheave flanges. So I said to him, "Mr. Ott, have you ever heard of fleet angle?"

"Sure," he said, "but what's that got to do with me?"

"Everything," I said. "That's the whole trouble. Either use a drum with shorter travel, or move the lead sheave up so the maximum fleet angle will be 1½ degrees. I'll lay you two to one that'll step up your rope life at least 50 per cent.

Yours,

Al

IMPROPER fleet angles cause wire rope to rub against the flange of the lead sheave and to side-swipe and pinch against adjacent rope winds on the drum. Experience has proved that you get most satisfactory service when maximum fleet angle is not more than 1½ degrees. That is equivalent to forty feet of lead for every foot of transverse travel to either side of the sheave centerline.

Be sure that all sheaves and drums are properly aligned. Otherwise, excessive flange and rope wear are certain to result. Another common cause of premature rope failure is reverse bending. Wherever possible, avoid reverse bends. If the equipment cannot be altered to eliminate them, use sheaves of the largest possible diameter to ease the severity of bending.

Don't let these faults in reeving rob you of the performance that is built into high-quality wire rope. Correct them now, and you'll begin at once to get the benefits of longer rope life and better all-round performance. Ask an American Tiger Brand Wire Rope Engineer to go over your equipment and make recommendations.

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BRIDGES

CONCRETE GIRDER, BELGIAN CONGO. Spannungsregelung beim Bau einer Eisenbetonbruecke ueber den Lualaba. R. Coppee-Bruessel. *Zement*, vol. 29, no. 4, Jan. 25, 1940, pp. 44–47. Stress regulation in construction of reinforced concrete girder bridge over Lualaba River in Belgian Congo; bridge is 498 m long and has 12 spans with widths varying from 30.7 to 70 m; method of construction described and illustrated, with special reference to distribution of stresses. From *Technique des Travaux*, July 1939.

HIGHWAY, DESIGN. Reinforced Concrete Highway Bridges in New South Wales, F. C. Cook and H. W. Cover. *Instn. Engrs., Australia—J.*, vol. 12, no. 2, Feb. 1940, pp. 65–75. Review of local practice in design and construction of reinforced concrete highway bridges of moderate spans; choice of site; preliminary office work; design of bridge details, superstructure, frames, piers, simply supported and continuous girder bridge superstructure; loads and stresses; design of bridge waterway; allowable stresses.

LIFT, NETHERLANDS. Die zweigleisige Hubbruecke ueber die Ringvaart bei Heerhugowaard (Holland), A. H. Foest. *Organ fuer die Fortschritte des Eisenbahnwesens*, vol. 94, no. 23, Dec. 1, 1939, pp. 443–449. Description of new lift bridge, 22.5 m in span, 3 m lift, carrying two railroad tracks across Ringvaart at Heerhugowaard, Netherlands; erection procedure; installation of mechanical equipment.

MASONRY ARCH, WIDENING. Ponts de Paris. Elargissement du Pont National. L. Netter. *Travaux*, vol. 24, no. 87, Mar. 1940, pp. 63–69. Report on extensive construction work for increasing width, from 7.7 m to 25.4 m, of old masonry arch bridge, known as Pont National, over Seine River, Paris, France, consisting of 5 masonry arches, total length 242.5 m; extension and strengthening of foundations; details of new reinforced concrete arch ribs; handling of steel centering for construction of new arch ribs.

PAINTING SCAFFOLDS. Permanent Painting Scaffolds for Golden Gate Bridge, R. G. Cone. *Eng. News-Rec.*, vol. 124, no. 17, Apr. 25, 1940, pp. 52–53. Detailed description of four permanent traveling scaffolds designed chiefly for painting steel work of Golden Gate Bridge at San Francisco, Calif.

PLATE GIRDER, NEW ZEALAND. Clutha River Bridge at Clydevale, F. D. Grant. *New Zealand Instn. Engrs.-Proc.*, vol. 25, 1938–1939, pp. 238–246, supp. plates. Design and construction of 7-span plate girder highway bridge, 703 ft long, at Clydevale near southeast coast of South Island, New Zealand; tests of concrete blocks; pile driving records.

PONTOON, VERMONT. Vermont Builds Floating Timber Bridge. *Pub. Works*, vol. 71, no. 4, Apr. 1940, pp. 41–42. Description of new pontoon bridge, about 300 ft long, across Colt's Pond at Brookfield, Vt., designed for H-10 loading and for expected life of some 50 years.

RAILROAD, MAINTENANCE AND REPAIR. Stress Computations for Bridge Maintenance, R. N. Brodie. *Ry. Eng. & Maintenance*, vol. 36, no. 5, May 1940, pp. 323–324. Author recommends extending calculations to structures, especially timber, supplementing field inspections.

RESUME, 1939. Bridge Works Overseas in 1939. *Surveyor*, vol. 97, no. 2511, Mar. 8, 1940, pp. 233–234. Brief descriptive notes on new bridges of various types in all parts of world.

RIGID FRAME. Design and Construction of Rigid Frame Bridge, G. S. Brown. *Instn. Mun. & Country Engrs.—J.*, vol. 66, no. 21, Mar. 26, 1940, pp. 609–630. Design and construction of rigid frame reinforced concrete bridge at Princes Park, Eastbourne, England, having 2 spans 24.5 ft clear; analysis of frame constants; temperature stresses; bending moments and normal thrusts; stresses in steel and concrete.

RIGID FRAME. Hollow-Ribbed Bridge of Rigid Frame Type Has Unusual Features. *Concrete*, vol. 48, no. 1, Jan. 1940, pp. 3–4 and 31. Bridge of reinforced concrete design, with hollow ribs and vertical legs, just completed in Elkhart, Ind.; bridge has three spans, center span of 116 ft in clear, and two end spans each 67 ft in clear; total width 54 ft 8 in.; made up of 40-ft roadway, and sidewalk and railing along sides; piers are also hollow; procedure followed in concreting and vibrating heavily reinforced hollow ribs of bridge deck is described.

RIGID FRAME. Rigid-Frame Bridges, E. Napier. *Roads & Bridges*, vol. 78, no. 4, Apr. 1940, pp. 13–15, 90, 92, and 94–95. Special advantages of rigid-frame concrete bridges; principles of design and construction of short-span, rigid-frame concrete bridges, particularly for grade-separation structures; effect of temperature variations; design of web reinforcement for concrete frames.

RIVER COVERING. Road over River Mersey at Stockport, E. Rhodes. *Engineer*, vol. 169, no. 4393, Mar. 22, 1940, pp. 284–285. Illustrated description of work in progress for covering 411 yd of river and constructing of reinforced concrete road; roadway between Mersey bridge and Lancashire bridge is to be carried on 54 portal frames, with expansion joint between each group of six portals; surface works will comprise 45-ft roadway with eight central islands and two 15-ft footpaths. See also *Engineering Index* 1938, p. 1047.

STEEL TRUSS, MARYLAND. Wichert Spans on Potomac Bridge. *Eng. News-Rec.*, vol. 124, no. 23, June 6, 1940, pp. 61–62. Description of new $1,000,000 highway bridge over Potomac River at Hancock, Md., including six-span continuous truss section, two five-span continuous plate girder sections, four-span continuous plate girder, and seven simple I-beam spans; features of Wichert pinned rhomboid panels over intermediate piers.

STEEL, WELDING. All-Welded Bridge for London Transport. *Civ. Eng.* (London), vol. 35, no. 406, Apr. 1940, pp. 110–113. Description of new all-welded steel girder bridge at Hainault near London, England, having clear span of 40 ft; details of main girders, floor beams, and parapet girders.

SUSPENSION, CABLES. Bridge Recabled After 12 Years' Service. *Eng. News-Rec.*, vol. 124, no. 17, Apr. 25, 1940, pp. 63–67. Method of replacing ungalvanized wire cables of suspension bridge at Portsmouth, Ohio, with cables made of strands of galvanized wire; extension of anchorage constructed to receive new strand sockets; breaks and rust in old cables.

SUSPENSION, SAN FRANCISCO–OAKLAND BAY. Sixth Annual Report San Francisco–Oakland Bay Bridge. Printed in California State Printing Office, Sacramento, 1939, 114 pp., figs., diagrs., charts, tables, maps. Official report on construction of bridge railway and facilities, bridge traffic and revenues, financing and administrative problems of bridge operation.

VIADUCTS, NETHERLAND. Viaduct Weteringkade-Schenkkade te 's-Gravenhage, M. H. Ekker. *Ingenieur*, vol. 55, no. 9, Mar. 1, 1940, pp. B. 47–55. Viaduct Weteringkade-Schenkkade in The Hague; description of pedestrian and vehicular viaduct for railroad crossing mainly constructed of armored concrete plates supported by two I-beams in longitudinal direction; length 650 m; greatest width 12 m over traffic line and 4 m each for two pedestrian sidewalks; calculation.

WOODEN. Treated Timber in Heavy Duty Composite Highway Bridges, W. C. Hopkins. *Baltimore Engr.*, vol. 14, no. 8, Feb. 1940, pp. 2–10. Review of practice of State Road Commission of Maryland in construction of composite timber-concrete highway bridges; description of loading tests; distribution of bending moments.

BUILDINGS

EXHIBITION BUILDINGS, NEW YORK CITY. World's Fair Trylon Gets Plywood Overcoat. *Construction Methods*, vol. 22, no. 5, May 1940, pp. 50–51 and 98–99. Methods and equipment used in covering 410-ft section of Trylon tower, at New York World's Fair, with 50,000 sq ft of exterior grade Douglas fir plywood, in order to eliminate difficulties resulting from atmospheric condensation inside Trylon.

MOTION PICTURE THEATERS. Motion Picture Theater Developments, M. Rettinger. *Soc. Motion Picture Engrs.—J.*, vol. 34, May 1940, pp. 524–533. Paper conveys basic requirements and recent developments in design of motion picture theaters with balconies to provide satisfactory conditions for all basic considerations of proper motion picture presentation; similar requirements pertaining to theaters with balconies; dimensional and constructional features. Bibliography.

STEAM POWER PLANTS. Small Steam-Pressure Increase Cuts Coal Cost $15,000 Year, R. H. Sogard. *Power*, vol. 84, no. 3, Mar. 1940, pp. 136–139. Installation of new 275-lb cross drum boiler and exhaust heating turbine generator at University of Missouri to serve higher steam and electric loads at much lower cost; feedwater system; illustrations of new equipment and cross sectional diagram of boiler given.

CITY AND REGIONAL PLANNING

EXPRESSWAYS, NEW YORK CITY. Trafficway Reclaims Waterfront. *Eng. News-Rec.*, vol. 124, no. 19, May 9, 1940, pp. 68–72. Features of new 6-lane East River Drive, 9 miles long, from Battery at tip of Manhattan, New York City, to Triborough Bridge at 125th St.; architectural rendering of Drive; details of complicated sections of Drive; financing.

CONCRETE

AIRPORT RUNWAYS. Sound Advice for Builders of Concrete Airport Runways. *Eng. & Contract. Rec.*, vol. 53, no. 12, Mar. 20, 1940, pp. 27–29. Good practical suggestions for design and practice of laying proper concrete runways. From "Concrete Highways and Municipal Improvements" issued by Portland Cement Assn.

ANTI-AIRCRAFT PROTECTION, SHELTERS. Hampstead's Air Raid Shelters, E. B. Brockwell. *Surveyor*, vol. 97, no. 2522, May 24, 1940, pp. 453–454. Construction of anti-aircraft shelters in one of London's boroughs; treatment of waterlogged Anderson shelters; communal shelters; strengthened basements; concreting in cold weather.

CONSTRUCTION, JOINTS. Rubber Joints. Development of Articulation for Large Concrete Canal Structures, H. G. Curtis. *Western Construction News*, vol. 15, no. 5, May 1940, pp. 155–159. Details of rubber joints and water stops used in construction of canal linings, bulkheads, and other structures of All-American Canal of U.S. Bureau of Reclamation, to take care of excessive temperature and shrinkage stresses.

CONSTRUCTION, PRE-STRESSING. Stahlbeton mit vorgespannten Zulagen aus hoeherwertigem Stahl, F. von Emperger. *Berlin, Verlag von Wilhelm Ernst & Sohn 1939*, 38 pp., figs., diagrs., tables, 3.30 rm. Results of experimental studies made at Vienna Institute of Technology on principles of design and construction of pre-stressed concrete members reinforced with high-grade steel wire; determination of bond strength of steel wire; use of pre-stressed concrete in construction of roofs, decks, buildings, railroad ties, etc.

FLOORS. Reinforced Concrete Ribbed Floors, W. S. Wilson. *Surveyor*, vol. 97, no. 2518, Apr. 26, 1940, pp. 371–372. Typical designs of reinforced concrete I-beam floors; numerical examples.

GARAGES. Concrete Lace Curtains for Walls. *Eng. News-Rec.*, vol. 124, no. 23, June 6, 1940, pp. 73–74. Details of thin architectural con-

BOWMAN FIELD at Louisville, Kentucky, has three 100-ft. wide runways ranging in length from 3150 ft. to 3600 ft. Also one apron 1800 ft. long, and one 975 ft. long—a total of 148,324 sq. yds. of concrete. Pavement built in 1938 with WPA labor under jurisdiction of the Louisville and Jefferson County Air Board, Lt. A. H. Near, Superintendent. Pavement of 7½-5-7½ inch cross section.

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crete slabs, 2-in. thick, hung from floors, utilized to form enclosing screen or openwork curtain around three-story Evening Star parking garage in downtown section of Washington, D.C.

GASOLINE TANKS. Procédés de construction des cuves et réservoirs à hydrocarbures en béton armé, L. P. Brice. *Travaux*, vol. 24, nos. 87 and 88, Mar. 1940, pp. 71–77 and Apr., pp. 115–120. Principles of design of reinforced concrete tanks for storage of gasoline and other petroleum products, with special reference to patented French, German, and Italian water-jacket designs; effect of gasoline on strength of concrete.

MIXING. Comparison of Mix Designs, N. M. Finkbiner, G. W. Harra, and O. A. White. *Eng. News-Rec.*, vol. 124, no. 25, June 20, 1940, pp. 63–64. Results of studies by Oregon State Highway Commission showing that special concrete mixes of low cement content are apt to be uneconomic from standpoint of work involved, that quality of cement has marked effect on strength and that sufficiently low water cement ratios are difficult to obtain.

MIXING. How to Make Good Concrete, H. N. Walsh. Westminster, England, *Concrete Publs. Ltd.*, Feb. 1939, 103 pp., diagrs., tables. 4s 6d. Text on selection, testing, and preparation of concrete aggregates and their proportioning for making of concrete; concrete testing; quality of materials; measurement of materials; sieve analyses of aggregates; principles of proportioning; type gradings; specifications; works control.

CONSTRUCTION INDUSTRY

CONTRACTS. Caution in Contracting Is War's Warning, R. F. Proctor. *Eng. News-Rec.*, vol. 124, no. 23, June 6, 1940, p. 78. Outline of contract safeguards against losses by contractors which may result from war service diversion of materials and labor and from increased prices. Before Carolinas Branch of Asssociated General Contractors.

DAMS

CONCRETE GRAVITY, TENNESSEE VALLEY AUTHORITY. Norris Project, Washington, D.C. U.S. Gov. Printing Office *U.S. Tennessee Valley Authority—Tech. Report No 1*, 1940, 840 pp., figs., diagrs., tables. $1.50. Detailed report on design and construction of Norris Dam, maximum height 260 ft; project investigations; powerhouse design and construction; access roads and employee housing; construction plant and river diversion; reservoir operation and related development; costs; model studies; cement and aggregate studies; acceptance tests; specifications. Bibliography.

EARTH, NEW HAMPSHIRE. Pittsburg Conservation Reservoir Development of New Hampshire Water Resources Board, R. S. Holmgren. *Boston Soc. Civ. Engrs.—J.*, vol. 27, no. 2, Apr. 1940, pp. 110–135. Design and construction of earth-fill dam, 100 ft high, 2,200 ft long, on Upper Connecticut River at Pittsburg, N.H.; organization and financing of project; features of reinforced concrete conduits, 13 ft in diameter, and of spillway having capacity of 4,600 cu ft per sec; highway relocation.

FISH HATCHERIES, LEAVENWORTH, WASH. Uncle Sam to Nurse Forty Million Little Fish. *Compressed Air Mag.*, vol. 45, no. 6, June 1940, pp. 6174–6178. Problems have arisen in connection with migratory fish; U.S. Bureau of Reclamation has driven 2,500-ft tunnel through spur of Cascade Mountains and tapped Snow Lake at point 150 ft below its surface, to make available cold lake water for maintaining low temperatures in holding ponds and fish hatchery under construction at Leavenworth, Wash.; details of construction work and arrangements for transfer of fish.

FOUNDATIONS. Application of Seismic Refraction Method of Subsurface Exploration to Flood-Control Projects, E. R. Shepard and A. E. Wood. *Am. Inst. Min. & Met. Engrs.—Tech. Publ.*, no. 1219, mtg. Feb. 1940, 13 pp. In program of flood control and navigation improvement, U.S. Army engineers have welcomed seismograph as rapid method of making subsurface explorations for selection of dam sites; theory of seismic exploration; field practice; application to different types of geologic formations; accuracy of data; exploration costs.

HYDRAULIC GATES. Closure Gates. *Reclamation Era*, vol. 30, no. 3, Mar. 1940, pp. 70–71. Development of steel gates, 35 ft high and about 52 ft wide, used in diverting Columbia from one to another group of low gaps in Grand Coulee Dam while spillway section is under construction; moving and installation of gates.

RESERVOIRS. Clearing Kachess Reservoir Area with CCC Forces, P. Taylor. *Reclamation Era*, vol. 30, no. 3, Mar. 1940, pp. 77–79. Methods used in clearing timber growth from 900 acres of site of Kachess Reservoir, Yakima Project, Washington; piling and burning of timber; man-days of work and costs.

FLOOD CONTROL

GAS PLANTS. Preparing Gas Plants for Floods and Hurricanes, G. F. Tyler. *Gas Age*, vol. 85, no. 13, June 20, 1940, pp. 21–26. Action taken by Philadelphia Electric Company, after minor flood in 1933; survey made to estimate possible extent of flood damage, to decide on preparatory measures, and to outline procedure to become effective when emergency arises; predicting severity of flood; determining essential plant operations; power, water, and communications; protective measures; plant operation during emergencies. Before Pennsylvania Gas Assn.

INDUSTRIAL PLANTS. Let Floods Come—We're Ready, G. R. Wescott. *Factory Mgmt. & Maintenance*, vol. 98, no. 1, Jan. 1940, pp. 73–75. Description of precautions taken by plant in Massachusetts on Quinebaug River, to keep water out; plant has organized 275-man flood squad, each of whose members knows just what to do in emergency.

IRELAND. River Barrow Drainage, T. L. Hogan. *Instn. Civ. Engrs. Ireland—Trans.*, vol. 65, Nov. 1938–May 1939, pp. 137–168, (discussion) 169–183, supp. plates. Hydrology of Barrow River in Ireland, with special reference to flood discharges; construction of works for flood protection and drainage in river valley; cost data.

NEW ZEALAND. Extraordinary Flood Discharges in Some Streams Near Gisborne on 19th February, 1938, O. G. Thornton. *New Zealand Instn. Engrs.—Proc.*, vol. 25, 1938–1939, pp. 65–72, (discussion) 73–91, supp. plates. Data on unusual rainfall and flood of Feb. 19, 1938, in Poverty Bay district on east coast of North Island, New Zealand, resulting in discharges as high as 3,338 cu ft per sec per sq mile for watershed of 7.25 sq miles.

TEXAS. Grouped Reservoirs Control Floods, C. McDonough. *Eng. News-Rec.*, vol. 124, no. 23, June 6, 1940, pp. 63–66. Description of $48,000,000 flood control project on Colorado River above Austin, Tex., including 4 dams and reservoirs, having flood storage capacity of about 3,000,000 acre-ft, which also provide 147,000 kva electric power, which, with sale of irrigation water, will amortize cost; advance storm information.

FLOW OF FLUIDS

OPEN CHANNELS. Open Channel Flow, J. C. Stevens and R. G. Kasel. *Iowa Univ. Studies in Eng.—Bul.*, no. 20, Mar. 1940, pp. 203–247. Papers presented at session of 1939 Iowa Hydraulic Conference; Backwater Curves in Theory and Practice, C. J. Posey; Propagation of Waves in Steep Prismatic Conduits, H. A. Thomas; Flood Forecasting in Upper Mississippi Valley, B. S. Barnes; Stage Transmission in Lower Mississippi River, G. H. Matthes.

TURBULENT. Turbulence, C. A. Wright. *Iowa Univ.—Studies in Eng.—Bul.*, no. 20, Mar. 1940, pp. 31–65. Papers presented at session of 1939 Iowa Hydraulic Conference: Criteria for Similarity in Transportation of Sediment, H. Rouse; Experimental Studies in Liquid Turbulence, A. A. Kalinske.

FOUNDATIONS

EARTH PRESSURE. Quelques remarques au sujet de la poussée des terres, E. Fricero. *Technique des Travaux*, vol. 16, no. 3, Mar. 1940, pp. 139–144. Theoretical discussion of pressure of non-cohesive earth masses against retaining walls.

EARTH PRESSURE. Remarques sur certaines formules de fondation, Gibert. *Annales des Ponts et Chaussees*, vol. 109, no. 11, Nov. 1939, pp. 437–447. Critical discussion of formulas on earth pressure against foundations of rectangular section.

PILES, DRIVING. Holes Pre-Bored for Underpass Falsework. *Eng. News-Rec.*, vol. 124, no. 19, May 9, 1940, pp. 82–83. Methods and equipment used in pre-boring of holes for pile foundation of underpass under three tracks of Baltimore and Ohio and Chicago Terminal Railway at Argo near Chicago, Ill., where hard clay and shale formation precluded driving of piles in ordinary manner.

SHORE PROTECTION. Submerged Barriers for Shore Protection, E. E. R. Tratman. *Engineer*, vol. 169, no. 4391, Mar. 8, 1940, pp. 226–228. Illustrated description of system employed on Chicago lake front; type of construction for new submerged structure consists essentially of single line of steel sheet piling, reinforced at intervals by hollow piles, built of interlocking steel sheet piles, filled with concrete.

HYDRAULIC ENGINEERING

HISTORY. Historical Development, F. M. Dawson. *Iowa Univ.—Studies in Eng.—Bul., No. 20*, Mar. 1940, pp. 1–30. Papers presented at session of 1939 Iowa Hydraulic Conference: Historical Development of Experimental Hydraulics, C. E. Bardsley; Experimental and Practical Engineering Hydraulics of Late 18th Century, J. J. Doland; (discussion) Results of Model Study of Cameron-Rutledge Mill, W. J. Putnam; Hydraulic Model Testing in Spotlight, P. W. Thompson.

HYDRAULIC STRUCTURES. Hydraulic Structures, G. H. Hickox. *Iowa Univ.—Studies in Eng.—Bul., No. 20*, Mar. 1940, pp. 129–169. Papers presented at session of 1939 Iowa Hydraulic Conference: Compilation of Reports on Hydraulic Model Studies, G. E. Barnes; Spillways and Energy Dissipators, J. E. Warnock; Manifold Problem in Lock Design, M. E. Nelson.

HYDRAULIC TURBINES, CAVITATION. Problem of Cavitation and Use of Models for Predetermination of Performance of Water Turbine Runners, A. P. Cooney. *Instn. Civ. Engrs. Ireland—Trans.*, vol. 65, Nov. 1938–May 1939, pp. 83–123, (discussion) 125–135, supp. plates. Study of causes of cavitation in water wheels; runner behavior under cavitation conditions; prevention of cavitation; methods adopted for repairs; selection of runner with increased output for existing installation; conversion of model results to those of full-size runner; relation between model, guarantee, and actual test figures.

SPILLWAYS, MODEL TESTING. L'evacuateur de crues du barrage d'Ermal Minho (Portugal), A. Stucky. *Bul. Technique de la Suisse Romande*, vol. 66, nos. 3 and 4, Feb. 10, 1940, pp. 25–30 and Feb. 24, pp. 37–42. Results of tests, made at Hydraulic Laboratory of University of Lausanne, Switzerland, of models of controlled overflow spillways of Ermal masonry gravity dam in Portugal; total capacity of two spillway gates, measuring 9 m by 5 m, is about 450 cu m per sec.

HYDROELECTRIC POWER PLANTS

MAINTENANCE AND REPAIR. Concrete Repair Methods, C. Gliddon. *Eng. J.*, vol. 23, no. 5, May 1940, pp. 217–219. Review of practice of Gatineau Power Co., Ottawa, Ont.; in repairing reinforced concrete structures of hydroelectric power plants.

SMALL STREAMS. Power Development of Small Streams, C. C. Harris and S. O. Rice. *Orange, Mass, Rodney Hunt Machine Co.*, 177 pp., figs., diagrs., charts, tables. Text for laymen giving practical information on installing and operating small water power plants for furnishing country homes and villages with electric light, power, heat, water supply, and fire protection; weir method of measuring water; turbine wheel; rim leverage wheel; dams; conduits; irrigation and drainage; installing water power plant; information for water power users.

SOUTH CAROLINA. Developing Santee and Cooper Rivers. *Eng. News-Rec.*, vol. 124, no. 21, May 23, 1940, pp. 42–45. Outline of $41,000,000 Santee-Cooper hydroelectric power and navigation project, involving construction of two long dams, chiefly of earth and sand fill, dikes, power plant of 173,000-hp capacity and navigation lock, of 75-ft maximum lift, that will permit barge traffic from Charleston to go up Santee and Congaree rivers to Columbia, S.C.

HYDROLOGY AND METEOROLOGY

BEACHES, EROSION. Vanishing Beaches of Southern California, A. G. Johnson. *Western City*, vol. 16, no. 5, May 1940, pp. 22–25. Observations on erosion of several beaches in southern California; planning for prevention of erosion.

SOILS, EROSION. Rainfall Characteristics as Related to Soil Erosion, D. I. Blumenstock. *U.S. Dept. Agric.—Tech. Bul. No. 698*, Dec. 1939, 44 pp. 10 cents. Report on observations at nine stations located in the Middle West and East to determine significance of precipitation factor in soil erosion; analyzing precipitation data; rainfall intensity factor; regional rainfall characteristics and their relation to soil erosion. Bibliography.

WATERSHEDS, DEVELOPMENT. Improving Run-Off at Perenjori Catchment, W.A., W. A. McCullough. *Commonwealth Engr.*, vol. 27, no. 9, Apr. 1, 1940, pp. 305–306. Method of increasing run-off from 8-acre watershed in western Australia by surfacing it with bituminous composition; cost data.

IRRIGATION

AUSTRALIA. Water Conservation and Irrigation from 1884 to 1917, R. T. McKay. *Australian Surveyor*, vol. 8, no. 1, Mar. 1, 1940, pp. 32–43. Early history of legislation, administration, and organization work for water conservation and irrigation in Australia.

FRENCH MOROCCO. Une Grande Oeuvre Française: l'Utilisation Agricole des Eaux au Maroc, A. Normandin. *Annales des Ponts et Chaussees*, vol. 109, no. 10, Oct. 1939, pp. 315–329. Review of progress in development of irrigation on coastal plains of French Morocco.

GROWING RICE. Water Requirements of Rice Irrigation, E. W. Lane, T. T. Cheng, and C. L. Pien. *Assn. Chinese & Am. Engrs.—J.*, vol. 20, no. 6, Nov.–Dec. 1939, pp. 233–252. Collection of available information on water required by growing rice; analysis of observed data and development of method of determining water requirements of rice; empirical formula for estimation of net duty of water for rice. Bibliography.

OVERHEAD. Portable Drag-Type Sprinkler Unit for Orchards, J. E. Christiansen. *Agric. Eng.*, vol. 21, no. 5, May 1940, pp. 182 and 186. Description of light-weight portable drag-type sprinkler unit developed recently for University of California experimental orchard at Paradise, Calif., consisting of 120 ft of hard temper tubing, with seven sprinklers 20 ft apart mounted on ½ by 6-in. copper-tube risers.

PIPE, CONCRETE. Concrete Pipe for Irrigation and Drainage, M. W. Loving. Chicago, Ill. *Am. Concrete Pipe Assn. Bul. 18*, 1939, 92 pp., figs., diagrs., tables. Suggestions on design and

Plant assembly of the spiral casing for the Flathead Development at Polson, Montana.
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HYDRAULIC TURBINES

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construction of irrigation pipe lines; methods of irrigating with concrete pipe systems; drainage in irrigated areas; action of tile drains; standard specifications for concrete irrigation pipe; examples of use of concrete irrigation pipe in western United States.

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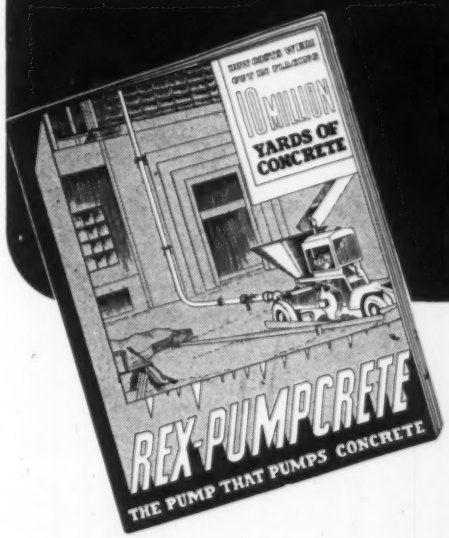

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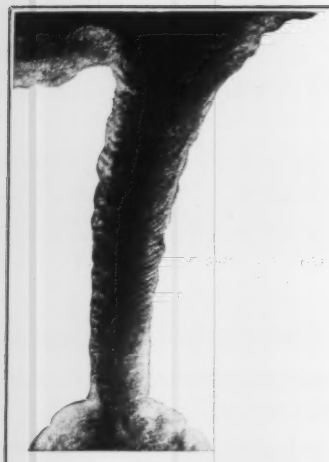

BORN in a typhoon of super-heated steam, a new form of natural graphite called *Typhonite*. Accurate control of the size of Typhonite particles assures uniformity in all 17 degrees of Typhonite Eldorado drawing pencils—even lines—stronger points. Try Typhonite Eldorado drawing pencils.

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These improved Sections develop higher beam strength coupled with decreased weight.

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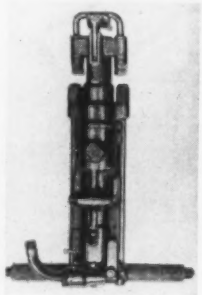
Powerful, Light, Sinker

DESCRIBED AS A SINKER to fill the need for a drill between the 55 lb type and the heavier machines weighing 75 to 80 lbs, a new 67 lb Sinker, known as the S-73 has been announced by the Gardner-Denver Company. According to the results of severe tests, this new Sinker has the speed and power of larger drills without the handicap of the additional weight. In actual operation, the manufacturer reports that the S-73 has the speed and power to drill in hard ground as fast and deep as the heavier drills, with an air consumption no greater than that of the average 55 lb drill.



As a result, the Gardner-Denver Company recommends this new Sinker for use where increased footage in hard ground is desired—for general drilling in the construction and quarry industries and in shaft sinking.

New A-C Diesel Tractor

ALLIS-CHALMERS Mfg. Co., Milwaukee, Wis., recently announced its third Diesel powered tractor, the new 54 hp Model "HD-7." In addition to low fuel consumption, the features claimed by the manufacturer are the following: long life for the Velvetouch bimetallic clutches and brakes; A-C Positive Seal on all truck wheels and idlers requiring lubrication only once each 200 hours of operation; a new track release spring mechanism which reduces wear on tracks and prevents unnecessary strain on other tractor parts.

This new 54 hp tractor weighs approximately 13,000 lbs in the 63 in. tread model, while the 52 in. tread machine weighs approximately 12,500 lbs. The four speed transmission gives a choice of forward speeds from 1.84 to 5.82 mph; reverse is 2.19 mph.

Equipment suitable for use with the "HD-7" includes 5 yd, two or four-wheel scrapers, 8 to 10 ft blade graders, sheepsfoot rollers, 7 yd wagons, and bulldozers.

Traffic Line Marker

BINKS MANUFACTURING Company, 3114 Carroll Ave., Chicago, Ill., announces the production of their Spray Line Marker, No. 240, which is a complete self-contained portable spray unit for the marking of traffic lines for highways, city streets, airports; wherever traffic lines are needed.

Equipped with a $^3/_4$ h.p. gasoline engine, a 12 gal material pressure container, and mounted on four pneumatic tires, the unit is ideal for one man operation. It will lay down a stripe from 2 in. to 6 in. in width at the rate of one to four miles per hour, depending on the condition of pavement or floor. Complete details will be supplied by the manufacturers.

New Wright Drafter

A NEW, COMPLETELY adjustable ball-bearing drafting machine, the WRIGRAPH Industro Drafter, for drawings up to 24 in. × 36 in. has recently been put on the market by L. G. Wright, Inc., 5209 Euclid Ave., Cleveland, Ohio.

The WRIGRAPH Industro Drafter, although very moderate in price, is a precision instrument available in four standard models. According to the manufacturer's report, the machine has a hinged mounting, permitting it to be raised clear of the board; leveling screw to adjust it to the plane of the drawing board; and is equipped with exclusive eccentric adjustments through which the machine is calibrated and its accuracy is controlled.

The arms of the INDUSTRO are of specially rolled channel steel, giving great rigidity. All steel parts are finished in black baked wrinkle enamel. Eight hardened ball-bearing assemblies are adjustable. The protractor head is controlled with the left hand and a new design features a No-Set-Zero. A one-half degree vernier equipped with a magnifier provides for a quick and accurate setting of all angles. Standard WRIGRAPH transparent edge engine divided scales are available in all standard graduations.

Wheel Type Trencher

THE BUCKEYE TRACTION Ditcher Co., Findlay, Ohio, has announced an addition to their line of rotary wheel type and boom type trenchers; a wheel type, designated the Model 12-A.

According to the manufacturer, the excavator wheel frame is of a new "trussed bridge" construction which provides greater strength and resistance to distortion. A "fluid coupling," which is optional equipment, protects transmissions from sudden shocks and prevents engine stalling.

Conveyor belt has new type of belt guide clips, developed by Buckeye, to insure even tracking of belt, and to minimize belt and pulley wear. Final drive is the Buckeye Constant Center Type.

The new Model 12-A cuts trench up to 26 in. wide and up to 5 ft 6 in. deep. Overall width (exclusive of spoil conveyor) is only 6 ft 8 in.; overall digging height is 8 ft $1^1/_4$ in. A wide range of cutting feeds, conveyor belt speeds and travel speeds are provided for all types of work. Bulletin 46 gives specifications and facts.

New Carryall Scraper

THE LATEST SINGLE BUCKET Carryall Scraper—the Model LS—rated at 8.2 cu yds struck capacity and 11 cu yds heaped, has been announced by R. G. LeTourneau, Inc., Peoria, Ill.

Several new features are reported by the manufacturer. Loading is made easier by a longer and steeper blade base. Additional yards are made possible by higher sides and a built up apron. A newly designed "A" frame gives more room for bigger loads, speeds up loading, facilitates dumping of sticky materials, and also adds structural strength. All hoist and unloading cables are now placed up and out of the dirt, eliminating abrasive cable wear. The power demands of larger loads are reduced by centering fixed sheaves at the tailgate so that a direct pull is attained on the positive ejection tailgate.

At the option of the purchaser, the Model LS Carryall can be fitted with either four or six large tires that give ample flotation and necessary compaction.

Better Concrete Surfaces Produced by Form Liner

TO MAKE CONCRETE surfaces denser, smoother and more resistant to abrasion, a new absorptive form liner board has been developed by The Celotex Corporation. For more than a year the company has cooperated with the U.S. Bureau of Reclamation at Denver, Colorado, in testing and improving the product which is currently being used by TVA on Watts Bar Dam and by the Reclamation Bureau on Friant California Dam.

Celotex Absorptive Form Liner is used on the inner surfaces of concrete forms. According to the manufacturer's report it absorbs air bubbles from the surface, and it removes excess water from the concrete directly in contact with the form, resulting in a surface of superior smoothness, hardness and durability. This structural change in the concrete is produced to a depth of $1^1/_2$ in. back from the face of the form, and it is claimed, blends with the interior so gradually that there is no plane of cleavage between the surface concrete and underlying mass.

Freezing and thawing, crazing, and abrasion tests were made by the Reclamation Bureau on concrete blocks cast in forms with Celotex Absorptive Liner. The results indicated the greater resistance of concrete cast in forms employing this new type of liner. Celotex Absorptive Form Liner is being offered in the standard product ironed on one surface and in a special textured liner.

Weighing Equipment in Paving Mix Plant

AN INTERESTING example of the utilization of modern weighing equipment is found in the Westchester Colprovia Corporation, manufacturers of a cold mixed asphaltic paving material, at Bedford Hill, N.Y. This plant, has a capacity of 85 tons per hour, with seven different mixes being manufactured each day, but because of its specially designed equipment, requires only eight men to operate it.

The weighing equipment consists of six Fairbanks Suspended Pipe Lever Hopper Scales, all equipped with dials. Two have 25 in dials and four have 20 in dials, each dial being furnished with outside spring clip markers in colors to represent the different aggregates. All the dials are mounted on tall pillars and set on fabricated steel shelves to facilitate easy reading. As the scales were designed for installation in very close quarters, special suspension rods and stiffeners were utilized to absorb the great amount of vibration caused by the various mixers and batchers.

Duplex Pump Alternator

AN AUTOMATIC alternator for duplex pumping equipment, is announced by Barclay Control Company, 5152 Division St., Chicago, Ill. Known as the Barclay Automatic Transfer Switch, this new device is said to provide a simple, positive means of alternating the sequence of pump motor operation, wherever duplex pumping equipment is installed.

The outfit consists of a fully housed controller unit with slotted operating lever, constructed to take all sizes of float rods and cables. It operates on alternating or direct current, and installation and wiring are said to be simple. Entire unit is mounted in a weatherproof, cast aluminum housing, and all internal parts are rust-proof, being made of aluminum, brass and bronze, cadmium plated. A new bulletin gives complete details.

Sewage Gas Booster

THE FIRST UNITS of the new Rotary Compressors, manufactured by Yeomans Brothers Co., 1433 Dayton St., Chicago, Ill., are being installed in the sewage treatment plant at Duluth, Minn. These units will act as sewage gas boosters, to store the digester gases in a Hortonsphere at 25 to 30 lbs pressure.

The Yeomans Compressors are of the multi-cellular positive displacement oil lubricated type with special heat resisting composition blades, to eliminate any scoring of cylinder walls. Although the wear of the blades is extremely slow they are easily and inexpensively renewable. Lubrication is mechanical force feed, with liquid sight feeds mounted on brackets on outboard cylinder heads, and driven from end of compressor shafts. These machines are equipped with ground metal shaft seals with automatic takeup. Both the compressor cylinders and shaft seal chambers are water jacketed.

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Big Housing Jobs—

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the world's largest—

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For all form-work—housing or industrial; large or small; intricate or simple—Richmond Tying Devices provide the right tie, better forms, and lower costs.

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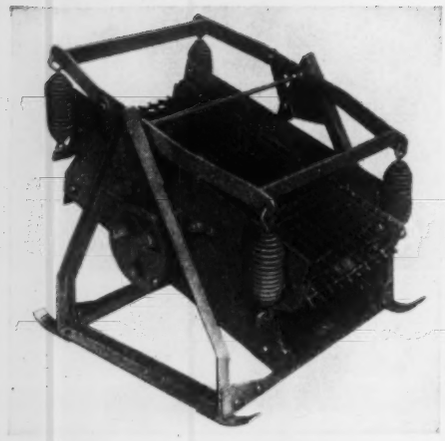

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For your next Bridge Floor (old or new) specify KERLOW VQ proven floors. They are strong, lightweight, non-slipping, skid-proof, and self-cleaning. Kerlow M floors are similar design but made for concrete fill.

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218-C Culver Avenue Jersey City, N. J.
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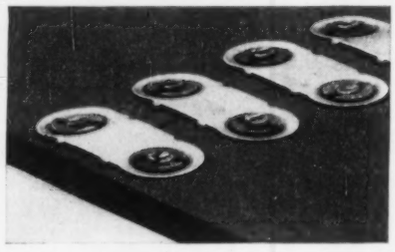
New Size Belt Fastener

FOR JOINING thin, light weight conveyor belts, Flexible Steel Lacing Company, 4607 Lexington St., Chicago, Ill., has added a new size to the line of Flexco HD Belt Fasteners. It is No. $1^1/_4$ and is used for joining elevator and conveyor belts from $^5/_{16}$ in. to $^1/_2$ in. thick.



No. $1^1/_4$ is constructed and applied in the same fashion as the other Flexco HD Fasteners. Metal plates span the joint on opposite sides of the belt and are drawn tightly together by two bolts through the belting. Bolt heads and nuts are countersunk and the protruding bolts are broken off; the fasteners are flat and smooth on both sides. The holding bolts are large size, yet, because of its short length, the new fastener will travel around pulleys as small as 14 in. diameter. The Flexco HD Fastener makes a tight butt joint, forming a compression seal that will not let material sift through. The completed joint, since it is a series of separate fastenings, can assume the trough of the conveyor.

Flexco HD Belt Fasteners are furnished in either steel, Monel, Everdur or Promal, depending on the specific conditions.

Literature Available

BLOWER EQUIPMENT—A 20-page bulletin No. 23-B12 illustrating and describing all types of blower equipment used in sewage treatment and water works plants has been issued by Roots-Connersville Blower Corp., Connersville, Ind. Volume-pressure curves and operating characteristics of both positive displacement and centrifugal type blowers are shown.

BYERS EXCAVATORS—New illustrated catalogs revealing latest improved specifications of Byers shovels, draglines, clamshells and back hoes are now available. Many new features are listed. The Byers Machine Co., Ravenna, Ohio.

COAL TAR ENAMELS—The A.W.W.A. STANDARD SPECIFICATIONS 7A.5 and 7A.6 are included within the covers of an institutional booklet on the use of Barrett Waterworks Primers and Enamels on important water projects. The Barrett Company, 40 Rector St., New York, N.Y.

CRAWLER-CRANES—Many novel industrial plant and construction job uses for crawler-type cranes are graphically portrayed and fully described in the new 32-page Bucyrus-Erie bulletin No. LCC-1. Bucyrus-Erie Co., South Milwaukee Wisc.

DIESEL ENGINES—More than a hundred typical installations of "Caterpillar" Diesel Engines are photographed and discussed in a 32-page booklet, Form 6056, "On the Job." Caterpillar Tractor Co., Peoria, Ill.

DUST CURE—A new booklet entitled "End Dust and Weeds," will be of particular interest to those annoyed by dust rising from roads, or similar unpaved areas. Solvay Sales Corp., 40 Rector St., New York, N.Y.

FILTER SYSTEM—A sub-surface filter system is concisely described and the units are illustrated in folder No. 302. Graver Tank & Mfg. Co., Inc., East Chicago, Ind.

GRADE CROSSING GATES—The need for adequate protection at grade crossings, and the efficiency of the Highway Guardian—a new folder. Highway Guardian Corp., 6th & Lloyd Sts., Chester, Pa.

HEATING—A non-technical discussion of the principles of radiant heating and reports of modern practice in installing such systems are covered in a booklet. A. M. Byers Co., Pittsburgh, Pa.

JAW CRUSHERS—Bulletin, entitled, "Jaw Crushers," covers the four general types of jaw crushers built by Allis-Chalmers Mfg. Company, Milwaukee Wis.; fine reduction, Dodge, Blake, and Superior. It illustrates and describes each, includes sketches showing the principle of operation, covers construction features, capacity and dimension tables.

NICKEL ALLOY STEELS—A sixteen-page booklet, the Working of Nickel Alloy Steels, contains data compiled from practice of 34 leading fabricators, on the effects of alloying elements, characteristics and applications, and heat treatment. Practical instructions for machining, broaching, drilling, tapping, threading, milling, sawing, grinding, welding, and gas cutting are also covered. International Nickel Co., Inc., 67 Wall St., New York, N.Y.

SEWAGE INCINERATOR—A most attractive and interesting catalog is The Nichols Herreshoff Incinerator Bulletin No. 210. In its 36 pages, are briefly covered the features of complete disposal by incineration; the incinerator installations made since the development of the Nichols Herreshoff in 1934; very clear descriptions of the construction and operation of the incinerator; and illustrations of many of the installations. Nichols Engineering & Research Corp., 60 Wall Tower, New York, N.Y.

STEEL PIPE—The advantages and many important installations of Alco Steel for water supply are given in Bulletin, No. 1021, Alco Products Division, American Locomotive Co., 30 Church St., New York, N.Y.

TRENCHING MACHINE—A camera and check sheets give the results on the performance of the new Buckeye 410 Boom Type Trenchers, in Bulletin 45. The Buckeye Traction Ditcher Co., Findlay, Ohio.

VALVES—A new catalogue of 306 pages, which is claimed to illustrate and describe the most complete line of steel valves and fittings in the world has just been issued by Crane Co., 836 S. Michigan Ave., Chicago, Ill.